

SUDAN GOVERNMENT



MINISTRY OF AGRICULTURE



ANNUAL REPORT

OF THE

RESEARCH DIVISION



1948/1949



McCorquodale & Co. (Sudan) Ltd.

1951

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GLOSSARY

1 Feddan	=	1.038 acres = 4200 sq. metres.
1 Rotl	=	0.99 lbs.
1 Kantar of		
Seed Cotton	=	315 rotls.
Abu Ashreen	=	A watering channel leading from a large canal.
Abu Sitta	=	A small watering channel leading from an abu ashreen.
Angaia	=	Sub-division of a plot of land bounded by a gadwal and a tagnet.
Anis	=	The grass <i>Sorghum purpureo-sericeum</i> , Aschers and Schweinf.
Asal	=	Honey. Term used for stickiness on plants.
Beladi	=	Native.
Berseem	=	Lucerne (<i>Medicago sativa</i>).
Bildat	=	Land, usually near a village, which is cultivated for several years in succession.
Dukhn	=	Bulrush millet (<i>Pennisetum typhoideum</i> , Rich.).
Dura	=	Giant millet (<i>Sorghum vulgare</i> , Pers.).
Gadwal	=	The smallest watering channel, leading from an abu sitta on to the land.
Gassab	=	Dura stalks.
Goz	=	Sandhill.
Hafir	=	Pit dug in the ground to collect rain water for use in the dry season.
Harig	=	A system whereby old, dry grass is burnt to kill off germinated weeds before sowing the crop.
Hawasha } Hosha }	=	The unit holding in the Gezira Scheme. In the case of cotton, 10 feddans.
Kharif	=	The main rainy season.
Khor	=	Watercourse with seasonal flow.
Komodob	=	Land under crop, which also bore a crop in the previous year.
Lubia	=	The fodder bean, <i>Dolichos lablab</i> , Linn.
Number	=	Unit of land irrigated by an abu ashreen in the Gezira Scheme, usually 90 feddans.

Sagia	=	Land watered by a water wheel, or the water wheel itself.
Seluka	=	Native sowing stick.
Tagnet	=	Ridge for controlling watering.

Abbreviations.

G.R.F.	=	Gezira Research Farm.
K.C.C.	=	Kassala Cotton Company Ltd.
S.P.S.	=	Sudan Plantations Syndicate Ltd.
k.p.f.	=	Kantars per feddan.
r.p.f.	=	Rotls per feddan.
G.O.T.	=	Ginning out-turn (as percentage of seed cotton).
S.E.	=	Standard error.

RESEARCH DIVISION

MINISTRY OF AGRICULTURE

ANNUAL REPORT FOR 1948/49.

INTRODUCTION

Survey since 1938.

The last report of the Agricultural Research Service to be published was for the season 1937/38. Since then some reports have been duplicated with a limited circulation, and it is not proposed to publish them since much material was of rather topical interest, and the work was summarised up to 1942/43 in Tothill's "Agriculture in the Sudan". In addition some work has been published in journals. It is hoped to publish a report annually in future.

Mr. T. Trought, Director of the Agricultural Research Institute, retired in 1943 to be succeeded by Mr. H. W. Bedford as Chief of the Research Division. Mr. Bedford retired in 1946 and was succeeded by Mr. O. W. Snow. The death of Dr. Frank Crowther in 1946 was a sad loss to his many friends and to agricultural research to which he had contributed so much. During and for some time after the war, there was a serious shortage of staff. Nevertheless various projects in connection with the war were undertaken among which may be mentioned milk production and vegetable growing for the army, and work on charcoal briquettes as a substitute for coal for the railways. The following mentions some of the notable developments between 1938 and 1948.

Most of the work was done in connection with the cotton crop of the Gezira Scheme owing to its peculiar importance in the economy of the Sudan. A correlation was established between Gezira yields and rainfall. Heavy rain from 1st July to 15th August—the date on which the cotton is sown—increases the yield; but heavy rain in the previous year has an adverse effect. By means of an equation combining these factors, it has proved possible to forecast the yield at sowing time with a fair degree of accuracy. The way in which the rainfall acts is not known. It is probable that the effect of the previous year's rain is connected with the growth of weeds on the fallows and the amount of nourishment which they take from the land which will be under cotton next year. In this connection it was proved that large increases in yield could be obtained by hoeing the fallow during the rains, in the year previous to the sowing of cotton, and that the earlier the weeds were destroyed, the better were the results.

Following the discovery of the large reduction in cotton yield caused by the attack of jassids (*Empoasca libyca*), spraying experiments were undertaken which showed that control of the insect gave large

increases in yield. As a result Messrs. Pest Control Ltd. were invited to carry out large scale trials in 1945 which were successful, and the area sprayed with DDT has increased each year. This annual operation naturally involves a large outlay, and it is hoped that some cheaper way of dealing with the pest may be discovered.

Apart from work on jassids, the efforts of the Entomological Section were mainly confined to the locust campaign. A new swarming cycle of the desert locust began in 1941 and developed rapidly, and most of the northern half of the country was heavily infested from 1943 to 1946. Owing to the food situation, campaigns were undertaken on a much larger scale than had been attempted before, and these occupied nearly all the staff of the section.

The main advance in cotton breeding was the production of blackarm-resistant Egyptian cottons. This was done by crossing with resistant American cottons and then back-crossing for several generations to remove all the American characteristics except the factors for resistance to the disease. The same process is being used to produce hairy Sakel for resistance to jassids, and the aim of the Cotton Breeders is to produce Sakel and X1730 (the two varieties grown in the Gezira) which will be resistant to leaf curl, blackarm and jassids. Breeding of American cotton has resulted in a quick maturing variety of good quality which is suitable for growing on rain in the Nuba Mountains.

An advance was made in the evaluation for irrigation of the alkaline clay soils of the central Sudan. By means of a new and simple test, combined with a study of the cotton yields at Dueim Pump Scheme, it became possible to assess the value of new land by comparing its soil profile with that of Dueim. The method, combined with field examination by Agricultural Inspectors, was used for advisory work in several areas, and it is now possible to avoid serious mistakes such as have occurred in the past in the development of new areas.

Summary of 1948/49 Season

STAFF

Mr. O. W. Snow (Chief of Research Division) and Mr. W. P. L. Cameron (Assistant Chief and Government Entomologist) went on final leave in May 1949, after 25 and 24 years service respectively. Both have contributed largely to agricultural research in the Sudan and will be greatly missed.

The Entomological Section suffered most from retirements at the end of this season. In addition to Mr. Cameron, Mr. J. W. Cowland, whose work led to the adoption of large scale jassid spraying, retired after 24 years service. Other retirements were Dr. A. D. Hanna and Mr. H. S. Darling. Mr. R. C. Maxwell-Darling was promoted to be Chief of the Research Division. Dr. W. S. Richards joined the Section in 1948. Mr. D. W. Mollison carried out entomological investigations at Tokar for six months, by arrangement with Messrs. Pest Control Limited.

The Cotton Breeding Section was strengthened by the secondment from the Empire Cotton Growing Corporation of two cytogeneticists, Messrs. H. D. Douwes and P. L. Cuany, and a cotton breeder, Mr. K. C. Barlow.

Mr. T. R. G. Moir retired from the post of Plant Breeder, Rainlands. Mr. P. de Schlippe was appointed to the post of Senior Research Officer, Yambio Experimental Farm. Mr. A. P. Moore, Inspector Plant Propagation, retired for reasons of health, and was replaced by Mr. C. G. Webster of the Field Division.

EGYPTIAN COTTON

YIELDS IN 1948/49.

The yields of the commercial crop in the last four seasons have been as follows in kantars of 315 rotls per feddan :—

	Season	1945/46	46/47	47/48	48/49	Variety	% Sprayed 1948/49
	Gezira	3.36	3.93	3.39	4.26	S & L	32
	Gondal	4.73	3.26	3.81	4.35	L	—
	A/Magid	3.00	3.00	3.07	4.01	L	90
White Nile	Dueim	2.28	2.72	2.83	3.75	L	68
Pump Schemes	Fatisa	1.95	1.92	3.62	4.69	L	95
	Hashaba	2.00	1.64	4.01	4.46	L	100
	Um Gerr	2.69	3.78	3.25	4.37	L	97
	Wad Nimr	3.32	2.83	2.91	5.81	L	99
Flood Irrigation	Tokar	2.27	1.81	2.40	1.35	L	—
	Gash	1.52	1.81	2.20	2.23	S & L	—

S=Sakel

L=X1730A

In the Gezira the yield was 3 per cent higher than had been forecast by the rainfall formula (p. 16). 78,000 feddans had been sprayed with DDT against jassids—more than double the area of the previous season—and it is tempting to attribute the increase over the forecast yield to this. The indications are however, that the increase from spraying was considerably less than usual this season. At Abdel Magid the area sprayed was nearly twice that of 1947/48, at Fatisa and Hashaba it was about the same as in 1947/48, while Dueim, Um Gerr and Wad Nimr were sprayed for the first time. The jassid attack on the White Nile Schemes was worse than in the Gezira and yields must be connected in part with increased spraying, although it was said to have been done too late at Wad Nimr and Dueim. All White Nile Schemes were manured with ammonium nitrate.

The Gash had a large area watered and gave good yields. Tokar had a very small area watered and also gave a poor yield—largely due to aphid attack. Average yields in the Gash and Tokar deltas are always much smaller than in the Gezira.

GEZIRA WEATHER 1948/49.

Presowing rains were average, late rains more than usual. The winter was exceptionally cold and at some periods damper than usual. The long cold winter extended over the whole Sudan in varying degrees. (p. 138).

PESTS AND DISEASES.

Except in the South Group, jassid infestation in the Gezira was less than for several years, although early in the season a heavy attack had been expected. The reasons appear to be connected with late storms which reduced the infestation (p. 110). Control in gardens during the dead season was a failure as reinfestation soon occurred. Acacia trees are suspected as the source of this reinfestation (p. 107). Nearly 78,000 feddans were sprayed in the Gezira and 15,000 in the White Nile Alternative Livelihood Schemes. 8,700 feddans were successfully sprayed by helicopter (p. 110). Analysis of 1947/48 yields and spraying dates indicates that early spraying gives the best results (p. 112).

In the Gezira, there was less pink bollworm than in 1947/48, but Egyptian bollworm was worse than usual, though still less than pink bollworm. In the White Nile Schemes, yields were greater than had been estimated in January and this was partly attributed to the comparative absence of bollworms. Pink bollworm was unimportant in the Gash and Tokar, but Egyptian caused considerable shedding of buds and small bolls. Sudan bollworm was worse than usual in the Gash, where it appears to be, on the whole, the most serious bollworm (p. 98).

Cotton thrips caused some damage in the central and southern Gezira, and did severe but local damage in some White Nile Schemes. A fair amount of damage was caused by the early thrips in the Gash (p. 99).

Investigations at Tokar showed that the Capsid bug *Creontiades*, and Egyptian bollworm were responsible for a considerable amount of shedding of buds and small bolls. Control of the bug by DDT is suggested. Cotton aphid was very bad at Tokar this season and caused a large reduction in yield. (p. 131).

Blackarm was not serious anywhere except in a few plots which had primary infection owing to the seed not having been properly disinfected. The Barakat Seed Farm had an unusually light infection, which may be attributed to its seed having all been liquid disinfected. This method of treatment is however too dangerous to operate on a large scale by the method employed at present, and the question of suitable machinery is being taken up. Various new seed disinfectants were tried out with varying results. (p. 53).

Leaf curl was not serious in the Gezira though there were a few heavy patches. In the Gash, the disease was much less serious than in 1947/48, which is probably due to almost all the Sakel cotton being sown on the 2nd rotation and to there being less ratoon growth. Whitefly, which carry the disease, were also less numerous than usual (p. 99). Further experiments in transmission of leaf curl, by means of whitefly, from plants suspected of harbouring the disease were carried out (p. 55). The disease can apparently be transmitted from the resistant variety X1730A to Sakel, only when the 1730 plant develops symptoms, and then only with difficulty. Of other plants tried, it was found possible to transmit the disease to Sakel from *Sida spinosa* only and then with great difficulty.

Fungal wilt was more prevalent than usual on the G.R.F. "Physiological" wilt attacked Sakel cotton in varying degrees of severity on the G.R.F. and also in patches in North and South Groups of the scheme.

A feature of the 1948/49 crop was the premature opening of the bolls and their appearance when they opened. The lint remained compact instead of fluffing out, and the locules often remained partly attached to each other. This had an adverse effect on grade but did not apparently reduce the yield much. A phenomenon of the season was the small amount of boll shedding and it is suggested that this may be connected with the bad opening—the plant carrying more bolls than it was able to nourish. Of climatic factors, the unusually low temperatures and high humidity of the winter stand out. The general impression is that water-strain in some form was involved.

FIELD EXPERIMENTS.

G.R.F. Yields.

The yield of Sakel was below average while that of 1730 was slightly above average. Plot 57 yielded even worse than in 1947/48. This is the Old Observation Plot and has been cultivated for 21 years on the rotation cotton-lubia-fallow with ammonium sulphate applied to the cotton and weeds hoed on the fallows. Up to 1945/46 the yield has always compared favourably with that of the commercial crop, yielding on the average 175 per cent of it. In 1946/47 however a sudden deterioration set in and this has continued and increased in the two subsequent seasons. Some anxiety is felt on this account, in view of the possibility of long continued application of nitrogenous fertilizer and fallow hoeing having a deleterious effect on the soil; this plot has had these treatments for a much longer period than any other land in the Gezira (p. 17).

Manurial Experiments.

In the organic manure experiments, cotton following lubia was better than that following fallow. The 10 year experiment on residual effects was completed, with the lubia treatments showing superiority.

The types of nitrogen experiment gave the same order of results as usual *i.e.* calcium nitrate better than ammonium nitrate and ammonium sulphate, and time of sowing being the best time for applying the fertilizer.

Phosphate and potash both gave small, significant increases. These fertilizers give small or insignificant increases on Gezira soil.

Fallow-Hoeing.

Results of hoeing 1947 fallows were poor which was to be expected as the rains in that year were light. But it was also noticed that the physical conditions of hoed soils was bad and this probably contributed to the poor results. The condition is attributed to the hoeing, particularly with horse hoes, interfering with the cracking

of the soil. Another objectionable feature of fallow-hoeing is that it encourages the weed *Sonchus* (a kind of dandelion), particularly on the G.R.F. where these experiments have not been grazed. In future they are to be grazed as this is the normal practice in the Gezira.

In the Permanent Fallow Hoeing of Cotton Experiment, hoeing the 1946 fallows increased the yield, but hoeing in 1947 had no effect or even decreased the yield. This is tentatively explained in terms of moisture and root development in connection with movement of nitrates in the soil

Weed killers had been applied on 1947 fallows, both before and after germination of weed seeds. Results this season were poor, as in the case of hoeing, but one (non-hormone) weed killer gave better results than hoeing (p. 21).

Weed Observations in fallow hoed areas.

These have been in progress for 3 seasons. Fallow weeding reduces the number of weed plants which appear in the following year, but the percentage of land covered by weeds is little altered. The effect of hoeing on numbers varies with different species, but *Sonchus cornutus* usually increases actually as well as relatively, and this weed is difficult to eradicate once it becomes numerous. (p. 36).

An interesting observation was that cotton adjoining bare, weeded fallow was damaged by blown soil during a strong wind, whereas cotton adjoining unweeded fallow was unharmed (p. 37).

COTTON VARIETIES.

Evelyn's Selected Domains Sakel yielded slightly higher in the Gezira than the regular Domains Sakel, but this did not happen in the variety trial. Spinning tests show Evelyn's to be slightly stronger and finer than the commercial Domains, but evidence to date is not considered sufficient to warrant the replacement of the regular Domains by Evelyn's (p. 69).

The severe attack of blackarm on the breeding plot at the G.R.F. was a good test for the blackarm-resistant varieties which significantly outyielded the others. (p. 69).

The cutting back of leaf curl resistant varieties to favour development of symptoms of the disease was continued. By discarding plants which developed the symptoms, it is believed that a strain which is practically immune to the disease will be evolved. (p. 69).

The production of a Domains Sakel type resistant to blackarm is complete as regards the gene B_2 and the product (BAR 14/7) will be propagated on a large scale this season. Straight selection within this type has yielded a leaf curl and blackarm resistant strain of which one feddan was grown (BLR 14/16). The addition of the gene B_3 to this strain is proceeding (p. 72).

Breeding for jassid resistance continued and it is hoped, by using BLR 14/16 as the backcross parent, to produce a Domains Sakel resistant to blackarm, leaf curl and jassids.

AMERICAN COTTON

YIELDS (k.p.f.).

Zeidab	(irrigated)	..	..	3.60
Kordofan	(rain grown)	..	..	0.98
Equatoria	(„ „)	..	..	1.13

The area in Kordofan increased to 65,800 feddans. Local and erratic rainfall affected the yield adversely and the cotton breeding plot at Kadugli had to be watered by hand.

The area in Equatoria Province was 9,500 feddans. A ten feddan propagation plot at Meridi yielded 4.96 k.p.f.

PESTS AND DISEASES.

Boll examinations in Kadugli area showed an increase in pink bollworm and a moderate infestation by Egyptian bollworm while Sudan bollworm was negligible. Infestation of stainer bugs in Kadugli area was the lowest for some years due doubtless to the droughty conditions. They were numerous in open bolls in Equatoria in December and are suspected of being partly responsible for poor seed germination. The cotton leaf roller caterpillar was worse than usual at Kadugli.

Pink bollworm, which is more serious at Zeidab than in other parts of the Sudan, does less damage than might be thought, as the early maturing cotton grown there enables the best of the crop to be picked before the bollworm infestation reaches its height. The Capsid bug *Creontiades pallidus* was found to be a serious pest at Zeidab. Small scale spraying indicated that application of DDT at the right time would be effective against this pest. (p. 100).

Blackarm was the only disease of note at Kadugli Farm with an effect most marked on the late plantings of the susceptible Pump Scheme Strain. The value of the resistant gene B₂ in the commercial crop (S.P. 84) was amply demonstrated. (p. 86).

COTTON VARIETIES. (p. 80).

The commercial crop, S.P. 84, is inferior to its predecessor Pump Scheme Strain, in one respect only; its lint is less mature when grown under very poor conditions. There is every indication however that this defect can be remedied by selection, and work is proceeding on 4 promising lines. Under the climatic conditions of a normal Kadugli season, Nyasaland selections tend to grow coarse and selections have been made to produce more open, less lush types. With the poor rains of 1948, however, this variety showed up well, indicating that it might be suitable for areas of lighter rainfall than the Nuba Mountains.

Work on producing an earlier maturing strain of Wilds 11 for Zeidab continued.

EXPERIMENTS.

3⁴ *Factor Experiment at Kadugli (p. 82).*

This experiment investigates the effects, on 3 varieties, of dates of sowing, spacing and number of plants per hill. Early July proved the best time to plant, and this factor had more effect on yield than the other 3 factors. The closest intra-row spacing (45 cms) was again the best. Interactions were not statistically significant, but there are indications that more plants per hill gives benefit in early plantings, and that the evil effects of late planting are not offset by using a quick maturing variety.

Cotton Interplanting Experiment at Yambio (p. 190).

If food crops could be planted among cotton without adversely affecting its yield, it would greatly add to its popularity in Equatoria. Trials were made with maize and datiro—a gourd. Datiro with cotton yielded fairly well and had little effect on the yield of cotton. But with maize, or maize plus datiro, interplanted with cotton, the maize was a failure and the yield of cotton was significantly reduced.

Deterioration of Cotton Seed in Equatoria.

Seed from different picking dates was examined. The germination deteriorated from 75 per cent (October pickings) to 35 per cent (December pickings). At the same time visual examination showed progressive deterioration in the quality of the seed. Stainer bugs became more abundant as the season progressed and are suspected of being the cause of the trouble. Experiments on storage conditions gave negative results as regards germination. (p. 182).

Manurial Trial in Equatoria.

Nitrogen at the rate of 40 rotls per feddan increased yields by 11 per cent. Neither silicophosphate nor rock phosphate had a significant effect. (p. 191).

DURA AND OTHER GRAIN CROPS

YIELDS.

Yields in the Gezira were considered good. Accurate figures are not available since tenants understate the yield. Yields were very variable and ranged from less than 1000 to 4700 rotls per feddan. The latter was from a late maturing variety in a demonstration plot in the northern Gezira. Samples from 2 plots of rain-grown dura on the G.R.F. gave yields of 340 and 950 r.p.f.

The average yield on the Mechanised Crop Production Scheme in Gedaref District was 760 r.p.f.

PESTS AND DISEASES.

There were a few reports of swarms of the desert locust during the summer but they disappeared without breeding. A local outbreak developed on the Red Sea coast on the Sudan-Eritrean border and necessitated control measures (p. 101, 103).

Birds caused a fair amount of damage particularly in Kosti and Fung Districts. A large scale campaign using explosives was carried out against the Sudan Diodora in its dry season concentrations along the Blue Nile (p. 120). A tour of Equatoria was made to find out the species and status of grain eating birds there. (p. 121).

Dura midge did considerable damage in the central and southern Gezira—particularly to late maturing varieties and to late sowings on the White Nile Schemes. It was not very bad on experimental dura at the Abu Habi, but plots were not near wild sorghum (p. 125).

The Rutelid beetle, *Rhinyptia reflexa*, caused severe damage to durum in eastern Kordofan by eating the developing seeds.

The grasshopper *Pnorisa* caused considerable damage to July sown seedlings in Gedaref District, and the Mechanised Crop Production Scheme was invaded by large numbers of *Aiolopus* when the grain was ripening. Serious losses occurred on the experimental plots, but the large blocks of dura suffered little. (p. 114) *Homorocoryphus* caused some damage in Equatoria.

The bug *Lygaeus pandurus* caused severe local damage near Kassala.

A number of seed dressings against smut were tested for comparison with copper carbonate. Most gave excellent control with irrigated dura. They are to be tried on the rain-grown crop next season. (p. 59).

EXPERIMENTS.

In the combined rotations, the C-D/L-F-F rotation gave the highest yield. Otherwise the rotations with fallow preceding dura did best, but those with cotton preceding dura did much better than usual, which was certainly due to the very poor cotton yields of these plots in the previous season.

Hoeing the fallow before cotton in rotation F-C-D reduced the dura yield. In the hoeing experiment on the F-F-D rotation, hoeing the 1947 fallow had no significant effect on yield. This agrees with the results on cotton

Methoxone at 2 lbs per feddan applied before the rains in 1947 was effective in controlling most weeds that year. But it significantly reduced the germination of dura sown more than a year later, with a rainy season between. Increases in yield from fallow weeding by the chemical were less than half that obtained by hand hoeing. Hormone weed killers are not so effective as Denocate or hoeing for quick removal of standing weeds, but their effect on seeds reduces subsequent weed growth. (p. 25 and 26).

Experiments were carried out at the M.C.P. Scheme, Gedaref, on varieties, spacing, sowing dates, old and new land and manuring. The evidence is that old land should be sown early, virgin land late. (p. 159). No significant response was obtained from nitrogen, phosphate or potash fertilizers. (p. 163).

A large number of varieties were tried at the M.C.P. Scheme. For the western part of the scheme, where the rainfall is 400—500 mms, Feterita Maatuk is the best variety for general use. Wad Akr is good but susceptible to grasshoppers. Mugud is recommended for late sowings on virgin land, provided rains have been good. The double-dwarf combine varieties did badly. (p. 161).

MISCELLANEOUS CROPS.

Although most research work continued to be carried out on cotton, a considerable number of trials were carried out in various parts of the country with lubia, rice, various legumes, groundnuts, sunflower, safflower, sesame, soya, jute, Deccan hemp, sann hemp and tobacco. These included experiments on groundnuts in Kordofan, and various oil seeds on the M.C.P. Scheme and trials of fodder legumes for the Gezira. Inoculants to encourage root nodulation in legumes were tried. These indicated that inoculation was desirable or necessary in the case of new introductions, but unnecessary for indigenous legumes which are established as crops.

CHEMICAL CONTROL OF CANAL WEEDS.

Canals, both containing water and being dried out during the dead season, were treated with Methoxone and Chloroxone towards the end of April. The effect on weeds was marked up to 7 weeks later, but less so after that. It was less satisfactory than in 1947/48, probably owing to the different formulation of the weedicides. There was no effect on the germination of dura and cotton irrigated from these canals 3 and 4 months later. (p. 42).

20 parts per million of copper sulphate was effective against *Chara fragilis* (p. 44).

SOIL RESEARCH.

Soil surveys were continued and dealt with areas in seven provinces. Two irrigable areas with good soil were found on the east bank of the Blue Nile, totalling over 20,000 feddans. (p. 138). Work continued at Yambio Experimental Farm, and Darfur Province was visited by a soil chemist for the first time. (p. 139).

The long-term examination of the 3-course rotation at the Gezira Research Farm for nitrates shows a reduction of nitrates in the top foot of soil at the end of the rains, and there is evidence that this is due to it being washed down to lower levels. (p. 142).

The evolution of carbon dioxide from Gezira soil was found to be small compared with most soils, in accordance with the known very low content of organic matter in Gezira soil. The incorporation of germinating cotton seeds in these experiments indicated that competition for oxygen may be important when cotton seed germinates in Gezira soil. (p. 144).

Examination of soils at the M.C.P. Scheme, Gedaref, did not support the view that moisture penetration was best on virgin land. (p. 150).

MISCELLANEOUS

An agricultural show, on a much more ambitious scale than had been attempted previously, was held at Wad Medani in December. An exhibit was staged in a large marquee illustrating the work of the Research Division. In addition there was a demonstration plot with some 50 different crops growing, many of which had not been seen before by most of the visitors.

The Gezira Research Farm herd of Kenana cattle won several prizes in the open classes at the Wad Medani Show. Some young stock were exported by air to Tripoli for breeding purposes. Preliminary nutritional investigations were carried out. (p. 34).

With the appointment of a qualified librarian, the organisation of the library is progressing rapidly.

PUBLICATIONS DURING 1948.

KNIGHT, R. L. The role of major genes in the evolution of economic characters. (*In Journal of Genetics*, Vol. 48, No. 3, 1948).

KNIGHT, R. L. The genetics of Blackarm resistance, VI. Transference of resistance from *Gossypium arboreum* to *G. barbadense*. (*In Journal of Genetics*, Vol. 48, No. 3, 1948).

KNIGHT, R. L. The genetics of Blackarm resistance, VII. *Gossypium arboreum* L. (*In Journal of Genetics*— Vol. 49, No. 2, 1948).

KNIGHT, R. L. Dictionary of genetics (*Chronica Botanica*) 1948.

WILSON, C. E. Birds causing crop damage in the Sudan (*In Sudan Notes & Records*, Vol. 29, Part 2, 1948).

R. C. MAXWELL DARLING

CHIEF OF THE RESEARCH DIVISION.

31st. October, 1950.

AGRONOMY AND PLANT PHYSIOLOGY SECTION

by

H. Ferguson and S. Gray

INTRODUCTION.

During the 1948/49 season the Agronomy and Plant Physiology Section continued to function under the handicap of shortage of senior staff. In spite of this the section carried out a large programme of experiments made possible by the conscientious work of the Sudanese staff.

All permanent experiments were continued and a number of short term ones completed. It was also found possible to make preliminary reconnaissances into past results, but until staff is at full strength it will not be possible fully to utilise these in the interpretation of current problems. The widespread bad opening of bolls in 1948/49 presented an unexpected problem which took up some time.

The section undertook no research work outside the Gezira but during 1948 visits were made to Yangambi (headquarters of the Institut National pour l'Etude Agronomique du Congo Belge), Yambio in Equatoria, and Darfur. These visits have been reported upon elsewhere.

Neither details of the experiments themselves nor detailed results are given in the following report and only those of special immediate interest are mentioned.

COTTON.

SEASONAL CHARACTERISTICS.

In 1948, presowing rains were slightly above average, and using the regression equations established by Crowther an average yield was estimated for the Gezira crop. Using the "40 Block" equation for the whole Gezira, the estimated yield was 4.14 Kantars per feddan. The actual yield was 4.26 Kantars per feddan. Though this was slightly better than the estimate, bad opening of bolls was universal and, associated with this, grades were the lowest on record. The bad opening of bolls showed many points of similarity to the condition known in India as "Tirak". Intensive study of the phenomenon is required before any conclusions can be drawn.

Notable features of the season's weather were heavier than usual late rains, temperatures that were higher and lower than usual, and a very prolonged cold winter with high relative humidity. As a result of the late rains, waterlogging effects occurred on G.R.F. cotton and on some of the commercial crop. The unusual temperatures and humidities were almost certainly associated with bad opening of bolls.

All the usual pests and diseases were present. At the Research Farm whitefly was very numerous, and in the Gezira whitefly, thrips and jassids were severe in certain places. For the first time in many years wilt were severe particularly on G.R.F. Sakel. It occurred in parts of the Gezira on both Sakel and Xi730A.

Observations made on the Observation Plots showed that soil nitrates were lower, and root systems were less well developed than usual, and both these features were certainly associated with nitrogen deficiency symptoms which appeared in November. Boll shedding was less than usual, but the weight per boll was also low and it appears that the plant tried to distribute its nutrients over more bolls than it could feed. Probably this was also associated with bad opening.

In the Old Observation Plot (plot 57) wilt, and defoliation associated with it, were severe, and this plot produced the lowest yield on record. Statistical examination of data from plot 57 showed a strong negative correlation between the yield, and the date and intensity of leaf curl infection. There was also a strong correlation between leaf curl and defoliation which leads to the conclusion that defoliation, and factors causing it, result in low yields, the leaf curl becoming apparent only because of the new growth encouraged by defoliation. The correlation between final yield and % N in the plant seven days after sowing, which had been established previously, did not hold good for the period 1935 to 1945.

EXPERIMENTS ON COTTON.

The following is a list of the experiments on cotton carried out in 1948/49 season.

Observation Experiments.

1. Old Observation Plot.
2. Gezira Observation Plots (at G.R.F., Hag Abdulla, Turabi and Abu Quta).
3. Gash Soil Observation Plot.
4. Root Observation Plot.

Rotation Experiments.

1. Continuous Cotton.
2. Two Course Rotation Demonstration.
3. Three Course Rotation Experiment.
4. Combined Rotations Experiment.
5. New Rotation Experiment.

Manurial Trials.

1. Farm Yard Manure Experiment.
2. New Organic Manure Experiment.

3. Old Organic and Green Manure Experiment.
4. Types of Nitrogen Experiment.
5. N.P.K. Experiment.
6. Residual Nitrogen Experiment.
7. Compost Trial.

Fallow Hoeing Experiments.

1. Effect of Fallow Hoeing on Rotations.
2. Permanent Fallow Hoeing Experiment.
3. Trial of Weed Killers on Fallow before germination of weeds.
4. Trial of Weed Killers on Fallow Weeds.
5. Fallow Hoeing and Nitrogen Experiment.
6. Fallow Hoeing, Nitrogen and Flooding Experiment.
7. Fallow Hoeing and Residual Effects of Flooding.
8. Fallow Hoeing and Residual Effects of Waterlogging.

Watering Experiments.

1. Effect of Different Methods of Disposing of Lubia Residues.
2. Fallow Hoeing and Irrigation in Northern Gezira.

Cultivation Experiments.

1. Individual Cultivations Experiment.

Pest Control Experiments.

1. Pest Control Experiment at Turabi.
2. Pest Control Experiment at Abu Quta.

Grade Experiments.

Experimental Fallows.

Pot Experiments.

1. Hormone Observations.
2. Compost Trials.

The majority of the above experiments are long term ones. In general results have confirmed those of previous seasons, and have not indicated any new trends caused by possible long term effects.

Combined Rotations Experiment.

In connection with the Combined Rotations Experiment a comparison of productivity of the different rotations was prepared and is given here as a matter of interest. Money values have been used as the basis for comparison, but it will be realised that these measure only the efficiency of the use of water and land, and do not take into account the social needs of the community, the stability of its agriculture, and other such considerations, which are important in choosing a good agricultural system. It is also important to note that the figures used do not give full weight to possible differential trends in soil fertility. It should be mentioned that these rotations were designed mainly with yields of cotton in view.

TABLE I.

Evaluation of whole rotations in Combined Rotation Experiment using average yields and recent prices.

ROTATION	VALUE OF PRODUCE PER FEDDAN UNIT.			
	Per Round	Per Feddan of land	Per Feddan watered	Per Feddan watered after 1st. January
	£E. m/ms	£E. m/ms	£E. m/ms	£E. m/ms
*				
C	8.580	8.580	8.580	8.580
C-F	15.125	7.653	15.125	15.125
C-F-F	20.075	6.692	20.075	20.075
C-F-F-F	23.320	5.830	23.320	23.320
C-D-C-L	39.128	9.782	9.782	19.564
C-F-D-C-F-L	47.364	7.896	11.841	23.682
C-D-F-C-L-F	50.611	8.435	12.653	25.306
C-F-F-D-C-F-F-L	50.433	6.304	12.608	25.217
C-F-D-F-C-F-L-F	56.970	7.121	14.242	28.485
C-D-F-F-C-L-F-F	58.551	7.319	14.638	29.276

* Here and elsewhere C=Cotton, D=Dura, L=Lubia, F=Fallow.

Returns from various rotations per unit holding—the unit holding being taken as that containing 10 feddans of cotton—would be as follows:—

TABLE II.

Rotation			Size of Holding feddans	Return per year per holding £E. m/ms.
Continuous	C	..	10	85.800
C-F	..	..	20	151.250
C-F-F	..	..	30	200.750
C-F-F-F	..	..	40	233.200
C-D	}	.. ..	20	195.640
C-L				
C-F-D	}	...	30	236.820
C-F-L				
C-D-F	}	.. ..	30	253.055
C-L-F				
C-F-F-D	}	.. ..	40	252.165
C-F-F-L				
C-F-D-F	}	.. ..	40	284.850
C-F-L-F				
C-D-F-F	}	.. ..	40	292.755
C-L-F-F				

It should be explained that, in the Gezira, irrigation water is comparatively plentiful from mid-July, when watering begins, until the end of the year. From the 1st. January until 31st. March, when watering ceases, supplies are strictly limited. This explains the significance of the column "Per feddan watered after 1st. January", and also the very open rotation practised on the Scheme, where half the land is fallow. This preserves the fertility of the land without manuring, and is economic because at present water, and not land, is the limiting factor.

Manurial Trials.

The only non-permanent manurial trial was the compost trial. In this a sample of compost prepared by the Sudan Public Health Service from town refuse was tried. Both in field and pot experiments it was found that responses to this manure applied at 40 rotls. nitrogen per feddan were not significant,

Fallow hoeing and weed killers.

Increase of cotton yield from hoeing the previous fallows was small or absent in the 1948/49 Fallow Hoeing Experiments. This was probably due in part to poor rains in 1947 season and in part to waterlogging effects during the early growth of the 1948 crop. The following undesirable features of fallow hoeing were noted in 1948 in the Gezira Research Farm and the Gezira: increase in certain perennial weeds, deterioration in physical condition of the soil, and wind erosion. Some of these effects are the result of fallow cultivation undertaken to destroy weeds, and therefore experiments with weed killers are of considerable interest as their use dispenses with this cultivation. In 1948/49 season the weed killers Methoxone Phenoxy and Denocate effectively controlled most weeds and resulted in small significant increases in cotton yield similar to that resulting from hand hoeing. Methoxone caused a slight significant reduction in the stand of the succeeding cotton crop.

TABLE III.

TRIAL OF WEED KILLERS ON FALLOW WEEDS.

Rotation : C-F-F-C.
 Variety : XI730A.
 Fallows : Grazed 1946, Experimental treatments 1947.

Treatment Yields.

(Kantars (315 rotls) per feddan).

	Treatments on 1947/48 Fallow	Yield	% Resow
A.	Not weeded	3.99 (100)	2.3
B.	Hoed with hand hoe	4.23 (106)	2.3
C.	Sprayed with 0.1% Methoxone (1 lb. per feddan)	4.11 (103)	14.7
D.	Sprayed with 0.1% Phenoxy (1 lb. per feddan)	4.40 (110)	4.5
E.	Sprayed with 0.1% Denocate (1 lb. per feddan)	4.76 (119)	3.4
	Significance Sig. diff. (P=0.05)	*	*** (2.9 approx.)

In another experiment Methoxone was applied at rates of 1 lb. and 2 lb. per feddan to the dry fallow before the rains and effected a certain amount of weed control.

TABLE IV.

TRIAL OF WEED KILLERS ON FALLOW BEFORE GERMINATION OF WEED SEEDS.

Rotation : C-F-F-C.
 Variety : XI730A.
 Fallow : Grazed in 1946. Experiment treatments in 1947.

(i) Treatment Yields.

(Kantars (315 rotls) per feddan).

	Treatment on 1947/48 Fallow	Yield	% Resow
A.	No weed control	4.61 (100)	3.8
B.	Weeds frequently hoed by hand hoe	4.76 (103)	4.3
C.	Methoxone at 1 lb. feddan applied before rains	4.68 (102)	3.4
D.	Methoxone at 2 lb. per feddan applied before rains ..	4.91 (107)	4.0
Significance Sig. diff. (P=0.05)		(N.S.) —	— — —

TABLE V.

(ii) Percentage of Land covered by weeds.

				Date of samples (1947)					Remarks
				1/8	8/8	21/8	28/8	2/9	
A	No weed control			% 20	% 36	% 47	% 53	% 53	Treatment B first hoed on 25/8.
B.	Hoed	....	....	20	38	47	10	10	
C.	Methoxone 1 lb/fed.	....		9	19	25	29	29	
D.	Methoxone 2 lb/fed.	....		6	12	18	20	20	

TABLE VI.

(iii) Dry Weight of Weeds per feddan on 21.8.47.

				Weight of weeds rotls/feddan
A.	No weed control	..	..	99.1
B.	Hoed. (Hoeing not yet done at sampling date)	..	..	71.3
C.	Methoxone 1 lb/feddan	..	..	30.6
D.	Methoxone 2 lb/feddan	..	..	35.0

Experiments with weed killers are continuing.

The effect of hormones, including those used as weed killers, applied direct to cotton plants was observed in a series of pot experiments. Thirteen different hormones were sprayed on cotton plants at concentration of 100, 50 and 10 parts per million. The effects of all treatments were recorded. No hormone at any concentration improved the yield of the plants.

DURA.

SEASONAL CHARACTERISTICS.

A number of heavy storms occurred about the time dura was sown and in some plots coincided with irrigation. Waterlogging resulted and poor germination and bad stand were common at the beginning of the season. The late rains adversely affected the crop by delaying weeding. When finally established the crop was a good one and produced much better yields than in 1947/48. Yields on badly waterlogged plots and on the cotton—dura—fallow rotation were low. *Striga hermonthica* was present in most plots but was less severe than usual and did not cause heavy loss. All other common pests and diseases were present in normal amount, except dura midge which was more severe than usual.

Dura Experiments.

The following list includes all the experiments carried out specifically on dura, or in which dura was an integral part, in the 1948/49 season.

Rotation Experiments.

1. Two Course Rotation Demonstration.
2. Three Course Rotations Experiment.
3. Combined Rotations Experiment.
4. New Rotations Experiment.
5. Fodder Rotations Experiment.

Manurial Experiments.

1. Farm Yard Manure Experiment.
2. New Organic Manure Experiment.
3. Residual Nitrogen Experiment.

Fallow Weeding Experiments.

1. Effect of Fallow Hoeing in Rotations.
2. Permanent Fallow Hoeing Experiment.
3. Trial of Weed Killers on Fallow before germination of weed seeds.
4. Trial of Weed Killers on Fallow Weeds.
5. Fallow Weed Destruction by tractor and hand hoeing.

Watering Experiments.

1. Effect of Date of Cotton Pulling and Flooding in Cotton—Dura Rotation.
2. Effect of Date of Cotton Pulling and Flooding and Fallow Hoeing in Cotton-Fallow-Dura Rotation.
3. Fallow Hoeing and Flooding Experiment in the Northern Gezira.

Variety Trials.

1. Variety Trial at G.R.F.
2. Variety Demonstration in the Northern Gezira.

Residual Effects.

1. Of Dura 4-Factor Experiment 1945/46.
2. Of Control of Fallow Weeds before cotton 1946/47.
3. Of Waterlogging and Fallow Hoeing of Cotton 1946/47.
4. Of Manuring and Fallow Hoeing of Cotton 1946/47.

Work on Rain Dura.

Work on Sudan Plantations Syndicate and Abdel Magid Dura.

1. Seleimi Rotation Testing area.
2. Abdel Hakim Experiment.
3. Abdel Magid Scheme Yields.

In the rotation and manuring experiments results were generally in keeping with those of previous seasons,

Fallow hoeing and weed killers.

Experiments were carried out on the use of weed killers on fallows before dura and their effect on the following dura yield. These were similar to those on cotton recorded above and for comparison the results are given in tables VII to IX.

TABLE VII.

TRIAL OF WEED KILLERS APPLIED TO FALLOW WEEDS.

Rotation : 1945 1946 1947 1948.

F — C — F — D.

Variety : Dwarf White Milo.

Treatment Yields.

(Air dry, rotls per feddan).

	Treatments on 47/48 Fallow	Heads r.p.f.	Straw r.p.f.	% Resow
A.	Fallow not weeded	1015 (100)	4530 (100)	5.0
B.	Fallow hoed during rains	1844 (182)	5616 (124)	5.9
C.	Fallow sprayed with 0.1% Methoxone in August. (1 lb. per feddan).	1226 (121)	3491 (77)	11.3
D.	Fallow sprayed with 0.1% Phenoxyl in August. (1 lb. per feddan)	1245 (123)	4449 (98)	8.8
E.	Fallow sprayed with 0.1 % Denocate in August. (1 lb. per feddan)	1467 (145)	4756 (105)	5.4
	Significance Sig. diff. (P=0.5)	** 333	** 995	** 3.0 approx.

TABLE VIII.

TRIAL OF WEED KILLERS APPLIED TO FALLOW BEFORE
GERMINATION OF WEED SEEDS.

Rotation : 1945 1946 1947 1948/49.

F — C — F — D.

Variety : Dwarf White Milo.

Treatment Yields.

(Air dry, rotls per feddan).

	Treatments on 47/48 Fallow	Heads r.p.f.	Straw r.p.f.	% Resow
A.	No weeding (Control)	779 (100)	3109 (100)	6.4
B.	Weeds hoed during rains	1466 (188)	4822 (155)	4.6
C.	Methoxone at 1 lb/feddan, no hoeing in June.	1027 (132)	3463 (111)	6.3
D.	Methoxone at 2 lb/feddan, no hoeing in June	1020 (131)	3270 (105)	10.3
	Significance Sig. diff. (P=0.05)	* * 354	* * 1128	* * 3.1 (approx.)

TABLE IX.

Percentage of Land Covered by Weeds.

	Dates (1947)						Remarks
	1/8	8/8	21/8	28/8	2/9	Late Date	
A. No Weeding	6	11	33	41	48	} No change	Treatment B hoed 1st on 25.8.47
B. Hoed	7	14	29	5	5		
C. Methoxone 1 lb. p.f.	5	6	18	29	29		
D. Methoxone 2 lb. p.f.	3	3	11	15	15		

It will be noted that, as with cotton, yields are improved, though in this case hand hoeing is relatively more effective than the weed killers. But Methoxone at 2 lbs. per feddan significantly reduced the germination of dura sown in 1948.

Effect of Date of Cotton Pulling.

The experiment on the "Effect of Date of Cotton Pulling" in the cotton-dura rotation confirmed the earlier finding that early pulling of cotton increased the yield of the following dura crop. In the cotton-fallow-dura rotation the effects of early pulling are largely eliminated in the fallow year.

Variety Trial.

The dura variety trial carried out in 1948/49 is of some interest as it was carried out on poor land and in a poor rotation (cotton-dura-fallow). The results indicate that short strawed varieties are the best grain producers for poor conditions.

The data given in Table X indicate that this is partly due to the fact that, in these varieties, more of the limited supply of nitrogen is available for the grain.

TABLE X.

DURA VARIETY TRIAL.

Rotation : F — C — D.

Treatment Yields.

(Air dry, rotls per feddan).

Tr. No.	Treatment	Heads r.p.f.	Straw r.p.f.	Estimated Recovery of * Nitrogen (rotls N/feddan)		
				Heads	Straw	Whole plant
1	Feterita 1931	608 (100)	3537 (100)	5.38	10.43	15.81 (100)
2	Mugud Khafif	468 (77)	6508 (184)	4.14	19.20	23.34 (148)
3	Wad Fahl	345 (40)	4532 (128)	2.17	13.37	15.54 (98)
4	Feterita Dwarf Managil ...	847 (139)	2529 (72)	7.49	7.46	14.95 (95)
5	Martin Combine	616 (101)	2276 (64)	5.44	6.71	12.15 (77)
6	Plainsman	746 (123)	2107 (60)	6.60	6.22	12.82 (81)
7	Cap Rock	548 (89)	2045 (58)	4.85	6.03	10.88 (69)
8	Westland	680 (112)	2108 (60)	6.02	6.11	12.24 (78)
9	Midland	359 (59)	3148 (89)	3.17	9.29	12.46 (79)
10	Queensland Kalo	721 (119)	3317 (94)	6.38	9.79	16.17 (102)
11	Wheatland Milo	999 (164)	1875 (53)	8.84	5.53	14.37 (91)
12	Feterita Suki	325 (54)	5592 (158)	2.88	16.50	19.38 (123)
13	Wad Hussein	582 (96)	3087 (87)	5.15	9.11	14.26 (90)
14	Dwarf White Milo	936 (154)	2372 (67)	8.28	7.00	15.28 (97)
15	Dwarf Hegeiri	886 (146)	2692 (77)	7.83	7.94	15.77 (100)
16	Gassabi	762 (125)	2256 (64)	6.74	6.66	13.40 (85)
Significance Sig. diff. (P=0.05)		*** 127	*** 532			

* In estimating N recovery the N content of grain, chaff, and straw of dura from unmanured plots of Feterita 1931 and Dwarf White Milo was used, as we have no record of N content of all the varieties included in this trial.

LUBIA.

SEASONAL CHARACTERISTICS.

In the case of both the July and September crops waterlogging

soon after sowing caused yellowing of the crop and encouraged *Macrophomina* wilt, which was more severe than usual. Wet weather in September encouraged bacterial disease. Whitefly were numerous throughout the season, but thrips were much less severe than in 1947/48 season. The coldness of the winter season stopped vegetative growth early and encouraged earlier and heavier seeding than usual. The season was therefore not a good one for lubia, and yields of fodder were generally low.

LUBIA EXPERIMENTS.

Lubia was included in the following experiments in 1948/49.

Rotation Experiments.

1. Two Course Rotations Demonstration.
2. Three Course Rotations Experiment.
3. Combined Rotations Experiment.
4. New Rotations Experiment.
5. Fodder Rotations Experiment.

Manurial Trials.

1. Farm Yard Manure Experiment.
2. New Organic Manure Experiment.
3. Residual Effects of N.P.K. applied to cotton.

Other Experiments.

1. Effect of Fallow Weeding in Rotations.
2. Old Observation Plot.
3. Lubia Watering Experiment.
4. Lubia Variety Trial at Research Farm.
5. Lubia Variety Trial in the Northern Gezira.

In most of the above experiments lubia was a crop incidental to the main experiment and yields of the lubia crop are not of major interest. Moreover lubia is less affected by rotation or manuring than any of the other main crops.

It will soon be essential to stop lubia watering throughout the Gezira on the scheduled date, December 31st., and the Lubia Watering Experiment was planned to compare this stopping date with a later one and to test certain methods of compensating for the early stoppage. The error in the experiment was high and no significant differences between different stopping dates or watering treatments were found.

In the Lubia Variety Trial the variety E.C.R. 135 produced both more fodder and more seed than the local one. It is well known

as a better seed producer, but local lubia usually produces more fodder. The superiority of E.C.R. 135 in 1948/49 was partly due to its comparative resistance to bacterial disease, and to the more adverse effect of cold weather on local lubia.

OTHER CROPS.

The experimental work on " Other Crops " in 1948/49 is listed as follows :—

Legumes.

1. Groundnut Variety Trial.
2. Miscellaneous Variety Trial.
3. Trial of Legume Inoculants.

Other Crops.

1. Maize Variety Trial.
2. Sunflower Variety Trial.
3. Wheat Variety Trial at Abdel Magid.
4. Miscellaneous.

The most important part of this work was carried out on legume crops. A number of observation plots of a variety of legumes were sown to provide preliminary data on how these grow under Gezira conditions and how they might fit into rotations with the minimum demand for water, minimum disturbance to other crops and maximum benefit to the soil. Some crops showed possibilities, but observations are being continued in 1949/50 and no conclusions will be drawn till these are completed.

An investigation on the effects of inoculation of legume seeds was carried out in the field and in pot experiments. Data were collected on the effects of bacterial inoculation on nodulation, production of dry matter, nitrogen recovery, and manurial value of a number of legumes. Briefly the results confirm the axiom that new introductions should be inoculated, that benefit will accrue in some cases though not necessarily in all, and that it is not necessary to inoculate established crops.

No outstanding results came from the trials on maize, sunflower, wheat and miscellaneous crops. Wheat, sunflower and linseed may be crops of some interest.

FARM MANAGER'S SUB-SECTION.

By M. C. Hattersley

The report covers the period May 1st, 1948 to April 30th 1949 on the agricultural side. The cattle section deals with the 12 months ending December 31st, 1948.

FARM AREAS.

In September 1948, when the majority of crops were growing, areas were approximately as follows :—

	1947/48	1948/49	
Cotton	204.500	261.675	Feddans.
Dura	139.100	100.400	"
Lubia	78.350	84.975	"
Berseem	26.250	37.000	"
Forests	12.000	12.000	"
Miscellaneous and Mixed	35.450	67.250	"
Offices, houses, buildings	42.500	67.500	"
Fallows	480.850	388.200	"
TOTAL	1019.000	1019.000	"

CULTIVATIONS.

A. GENERAL.

1. As for 1948/49 season; cultivations for 1949/50 croppings commenced in November 1948. Cultivations on experimental areas with fixed dates proceeded to schedule.

B. DISPOSAL OF CROP RESIDUES—WEEDING AND CLEANING.

The pulling-out of the 1947/48 cotton, sweeping and burning debris was successfully accomplished by the official date, May 31st. 1948.

Weed growth was rather uneven this season despite the rainfall figures up to August 1st. being higher than normal. Very little weed growth had taken place by this date except on July-sown irrigated areas and certain low-lying spots. An outstanding feature of weed growth appeared to be the considerable amount which took place on fallow plots 201-216, 217-232 compared with the poorer growth which took place on prewatered cotton areas, indeed all but a few cotton areas were "sown clean" without any previous weeding.

All crops and fallows had been weeded once by mid-September and by the end of September the fallows required another weeding ; other weeds may perish, but the ubiquitous *Sonchus* sp. persists everywhere.

C. EXPERIMENTAL FALLOW HOING.

1. Plots 41, 42, 43. Fallow 1948/49. East half fallow-hoed, west halves untreated.

The possible ill effect of shallow fallow hoeing are strikingly demonstrated on those plots which were hoed chiefly by Garrett horse hoe at intervals during the season.

On the hoed portions of the plots it was almost impossible to tractor-cultivate for 1949, 50 croppings ; the heavy Ransomes C.E. 1. cultivator either dug right into the ground, pulling up huge clods or stalling, or else skidded over the pan-like layer which had formed about 2-4" below the loose surface of soil. The unhoed portions of the plots cultivated normally and broke down easily to a good tilth. Special emphasis is given to this as the differences between the hoed and unhoed areas were exceptionally striking.

2. Plots 63, 72, 73, 26, 28. Methods of Fallow Hoeing Experiment. Treatments applied between 20.8.47 and 20.9.47.

6 Treatments 5 replicates. Treatment area = 3.733 feddans.

Cotton variety X1730A. Sown 12.8.48.

<i>Treatments.</i>			<i>Yield k.p.f.</i>
A. Knife attachment (Tractor)	..	..	4.77
B. Martin cultivator (Tractor)	..	..	4.65
C. Tandem disc harrow (Tractor)	..	..	4.86
D. Countess junior disc (Bulls)	..	..	4.94
E. Garrett horse hoe (Bulls)	..	..	4.85
F. Hand hoe (Control, normal practice)	..	..	4.72

Cultivations for cotton followed standard practices. Weeds developing on 1948 rains were very light. No developmental differences were observed during the growth of the crop.

D. TRACTOR RIDGING AND INTER-ROW CULTIVATIONS.

With the Fordson Major tractor and tool bar equipment considerable success was obtained in ridging for cotton. Re-ridging when the plants were some 6-9" high was carried out very successfully ; the tractor wheels, adjusted suitably to standard 80 cms. spacing and with pneumatic tyres, can run over the cotton (where lack of headlands necessitates) doing practically no damage. The work is superior to bull-work, cheaper and faster.

MAIN CROP AREAS.

A. COTTON.

Seed was not liquid disinfected in 1948 but was dusted with Abavit. All areas were prewatered with the exception of plots 247, 248 and 259.

Plots 247, 248 suffered from heavy storm-water flooding and were under about 1 ft. water from 24-36 hours on September 7-8th, the cotton was in jeopardy but appeared to make fair recovery ; by the end of the season however, the cotton was very small.

Insect pests were never very serious. Wilt occurred sporadically but was slight on the new extension areas, although present. First pickings on the better cotton were later than usual ; bolls opened

in a flush in early February, and on the poorer cotton right to the top of the plant ; this led to more cotton being picked earlier than usual, in spite of the later start.

This, together with the very heavy leaf shedding late in the season due to an unknown cause, plus the imperfect opening of a proportion of the bolls, comprised the outstanding features of the season.

Yields.

Three Course (old farm area).

<i>Plot</i>	<i>Sown</i>	<i>Variety</i>	<i>K.P.F.</i>	<i>Rotation</i>
18	13.8.48	X1730A	3.18	D-F(Hoed)-C
19	16.8.48	X1730A	3.47	D-F(Hoed)-C
22	13.8.48	American S.P.84	2.32	D-F(Hoed)-C
"	"	P.S.S.	2.42	
27	17.8.48	X1730A	2.62	D-F(Hoed)-C
114	23.8.48	X1730A	5.01	L-F(Hoed)-C

Commercial Rotation (new extension).

243	23.8.48	X1730A	4.38	F-F(Hoed)-C
247	25.8.48	X1730A	3.23	F-F(Grazed)-C
248	25.8.48	X1730A	2.83	F-F(Grazed)-C
259	18.8.48	X1730A	5.02	L-F(Hoed)-C
260	14.8.48	{ M.S.D.S.	3.45	L-F(Hoed)-C
		X1730A	4.88	
262	14.8.48	M.S.D.S.	3.19	L-F(Grazed)-C
263	15.8.48	X1730A	4.87	L-F(Grazed)-C
264	15.8.48	X1730A	4.93	L-F(Grazed)-C

This was one of the easiest sowing seasons, all plots being sown in less than 14 days.

B. LUBIA.

There was only one plot of July-sown lubia. This was ECR/135, a purple flowered variety with some resistance to bacterial disease; it nevertheless suffered from this cause.

September-sown lubia was extremely patchy on the new extension area, termites showing considerable activity and killing off many holes. This, together with an attack of *Macrophomina* sp., appeared to account for the poor yields ; apart from the bad stand due to these causes growth was healthy and vigorous, and the second growth after the first cut, 6-9" above ground, was abundant.

Average yields 1st. cut on same rotation :—

1946/47	16,700	rotls per feddan	fresh wt.
1947/48	10,975	" "	" "
1948/49	9,710	" "	" "

The lubia was cut somewhat earlier than usual but was flowering at the time of cutting. The methods of disposal of this crop are various and it is doubtful if the old standard practice of cutting at $4\frac{1}{2}$ months is economically the soundest. Somewhat more weight may be obtained by this method rather than by cutting at earlier flowering, but it is liable to be made up of thick stem and seed pods whereas earlier cutting gives a larger proportion of leaves. There are also indications that second growth is more vigorous after an early 1st. cut.

C. DURA.

No main crop dura was grown this season as the dura area was reduced by about 30 per cent and was all under experiments.

D. BERSEEM (LUCERNE).

The following yields are given as fresh weight in rotls per feddan for 12 months :

1st. year plots	..	..	..	32,000
2nd. „ „	..	..	..	18,500
Average of all ages	..	..	..	11,500

CATTLE

A. DISEASES.

On the whole 1948 could be considered as a satisfactory year in the history of the Kenana herd. There was a setback in March due to an outbreak of suspected foot and mouth disease among the milking cows and other female stock. Vesicular stomatitis was diagnosed at first but subsequently some foot lesions developed. 21 out of 109 cattle were affected but after the first outbreak, followed by immediate isolation measures, no new cases occurred. Milk yields dropped about 40 per cent for a short period. The disease was reported as prevalent throughout the Gezira area.

Two cases of mastitis occurred in February 1949, both of which responded rapidly to treatment.

The fact that no case of hoven occurred during the year is attributed to closer supervision of feeding and grazing but a different season may prove otherwise.

A summary of diseases contracted over the last 3 years includes Rinderpest, Haemorrhagic Septicaemia, Anthrax, Foot and Mouth disease, Mastitis, Hoven and Milk Fever making a grim list ; nevertheless the herd flourishes, and it is astonishing how few animals are lost from these causes and how speedily recoveries are made. It is perhaps worthy of mention, pertaining to speculation on this hardiness, that the tillage animals have, with the exception of hoven, remained healthy throughout.

B. AWARDS.

The following awards were taken in the open classes at the Gezira Agricultural Show :—

Stud Bull	..	..	" Atebrin " ; 1st.
Stud Bull	..	..	" Cyprus " ; 4th.
Dairy Cows	..	..	" Om Rish " ; 1st. " Eritrea " 2nd.
Heifer Calf	..	..	" Cynthia " ; 1st.

Mr. La Riche, of the Agricultural Department, B.M.A., Tripoli, visited the G.R.F. to select some young stock to fly back to Tripoli for breeding and tillage purposes. He declared it was well worth while to have seen our cattle, and was well pleased with his selections.

C. BREEDING POLICY.

Continued on the lines laid down and the dual-purpose aspect remains predominant (milch cows and working bulls).

" *Atebrin* ". Now in his 10th year is fit and virile and a further 9 male and 9 female of his calves were born in 1948. His total well balanced progeny to 31st. December 1948 is 32 males and 31 females.

" *Cyprus* ". The second stud bull, which is being bred to " Atebrin's " heifers, has produced 5 female and 5 male calves.

Severe culling is enforced of animals not up to standard, and the herd book contains 34 living, home-bred females of known parentage. Several young bulls of known breeding are showing excellent promise.

D. FEEDING (Preliminary Nutritional Investigations).

Followed the lines laid down in previous reports, total issues of air-dry matter are given below and their previous ratios to body weights have been approximately maintained.

The seasonal difference in types of food are governed by their availability and yields.

Total Issues Air-Dry Matter to Herd over Period 1946/48 (rotls).

		1946	1947	1948
Dura grain	.. ..	90,520	72,000	104,028
Cake	.. ..	86,060	83,930	50,710
Gassab (dura stalk)	.. ..	226,930	211,200	383,726
Lubia hay	.. ..	132,680	116,090	48,970
Extras (estimated)	.. ..	16,060	77,810	47,111
TOTAL	.. ..	587,250	561,030	634,545
Av. Herd Wt. during year. (lbs.)	.. ..	77,000	80,000	82,000
Known dry matter issued per 100 lbs. body Wt. daily. ..		2.1	1.9	2.12

It is well realised that these figures are of a very general nature and show nothing of the requirements for different classes of animals, and the value of grazing is still an unknown factor. Within the total figures shown, a balanced diet as far as possible is fed to the different classes and the ration adjusted by baled lubia or fresh lubia grazing.

It is felt however that any further investigations should be precise experiments, which are at present impossible.

Records will continue to be kept as they are of considerable value in determining costings, and, the number of animals which could be kept on the available fodder.

E. CALVES AND REARING.

General.

Year				Calves born	Total Milk Produced
1946	..	..	..	16	65,400 lbs.
1947	..	..	..	24	71,200 "
1948	..	..	..	27	79,050 "

Rearing.

During 1948 calves were fed as follows :—

1st. week. All the colostrum and milk they could consume from bucket and dams.

2nd. week (and up to 1 month) by bucket up to 12 lbs daily

2nd. month " " " " 10 " "

3rd. month " " " " 8 " "

Green fodder and a little crushed grain was gradually introduced into the diet.

Some trouble was experienced from diarrhoea and the calves were slow in learning to feed from the pail. Later in the year, in the light of an article by Prof. F. V. Sheehy (J. Min. of Agric.), calves were fed from the first day by pail alone and given 3 feeds a day for the first month. Since the introduction of this technique no digestive troubles have occurred and calves, which are never allowed to suckle, soon learn to feed from a pail.

The degree of success is indicated by the following figures :

	1947	1948	1948
	Average for	Average for	Average for
	17 calves fed	14 calves fed	5 later calves
	by suckling	by pail and	fed by pail
		suckling.	only 3 times
			daily.
Birth Wt. (lbs.)	.. 52.4	57.8	48.6
Wt. at 6 weeks	.. 110.0	96.1	106.6
Wt. at 12 weeks	.. 150.0	137.4	157.0
Av. Wt. at 6 months	220.0	220.0	

Recent feeding by pail has been more successful and calves fed by pail from the 1st day and not allowed to suckle have more nearly approached the average weights for suckled calves.

The lower early weight for pail-fed calves appears to adjust itself, in practically all cases, by the time the calf is six months old, and no untoward effects have so far been observed on account of the slow early development. Nevertheless the more recent improvement is satisfactory.

F. MILK YIELDS.

	No. of Lactations	Av. days	Av. yield (lbs.)	Av. lbs. per cow per day.
1947	18	180	2,950	16.8
1948	12	221	3,414	15.4

SECTION OF BOTANY AND PLANT PATHOLOGY

A. Economic Botany.

by

F. W. Andrews and K. Wilson Jones

WEED OBSERVATIONS

Observations have now continued for 3 seasons on the S.P.S. and K.C.C. fallow weeding areas in Remeitab, Tayiba, Abdel Galil, Turabi and Feteis, and it is felt that in addition to the report for 1948 it is now possible to discuss the collected results over the entire period, and to outline the approach for future years.

From the results obtained it is now possible to confirm the suggestion of last year that fallow weeding is effective in reducing the numbers of weeds appearing in the following year. This may be due to one or both of two factors :

- (1) The reduction in weed seeds matured and dispersed over the ground.
- (2) The effect of fallow weeding in producing bigger and better plants as it does with cotton, thus enabling the stronger plants to smother out the weaker plants.

It is interesting to compare the reduction in total and individual weed averages per square metre, prior to weeding in 1948, on areas which were fallow in 1947 :—

Group		North	Centre	Messel- lemia	South	K.C.C.
Treatment 1947						
Total Weeds	Weeded 1	92.7	77.3	78.4	39.8	33
	Unweeded 2	161.8 ^s	69.3	104.7 ^s	95.0 ^s	71 ^s
Rehan	1	1.6		10.2	2.0	5.5
(<i>Ocimum basilicum</i>)	2	4.6		6.1	8.7	7.0
Tehr and Hantut	1	5.8		17.4	3.2	3.0
(<i>Ipomoea</i> spp.)	2	7.4		26.7	6.5 ^s	11.3
Um Galoot	1				1.0	7.3
(<i>Leucas urticaefolia</i>)	2				3.8	8.0
Moleita	1	1.8			9.7	
(<i>Sonchus cornutus</i>)	2	0.9			2.2	
Um Malbeina	1	16.6		4.3		5.8
(<i>Euphorbia acgyptiaca</i>)	2	41.1 ^s		9.8 ^s		11.3
Molokhiya	1	15.4				5.8
(<i>Corchorus</i> spp.)	2	12.5				15.7
Surib	1	28.4		9.3		
(<i>Phyllanthus niruri</i>)	2	72.3		14.8 ^s		
<i>Acalypha indica</i>	1			8.6		
	2			12.7 ^s		
Sofeira	1			2.9		
(<i>Crotalaria</i> spp.)	2			5.3 ^s		
Um Hebeiba	1			7.4		
(<i>Oldenlandia strumosa</i>)	2			5.0		
Danab el Agrab	1			0.8		
(<i>Heliotropium</i> sp.)	2			4.5		

1=Weeded

2=Unweeded

s=Significance equal to or better than 5 %.

It is rather suggestive that in the only two areas where it is present in quantity, the *moleita* is actually as well as relatively increased. Although neither case is significant; there is here a warning that if fallow weeding is going to eradicate annual weeds it may open up prospects of increased *moleita* infestation, resulting in a long-term change for the worse. In this respect the increase in recent years of this weed on the G.R.F. (reported by the Farm Manager) with its vastly increased weeding costs, may be regarded as a danger signal.

A further point to be considered is that of soil erosion by wind action. Fallow weeding, it seems reasonable to suppose, will lead eventually to a very considerable decrease of soil cover, and wind erosion would then become a risk. A case has been observed where a cotton number lying adjacent to a weeded number (Tebub Block) was severely damaged in the portions alongside the fallow-weeded fields as a result of a cross wind. Cotton adjacent to normal unweeded fallow was unharmed, but the damaged cotton looked "as if sand papered" by blowing soil.

Apart from damage to cotton, the wholesale removal of soil from place to place by wind may lead later to watering difficulties. Perhaps a "smother crop" of some vigorous-growing annual fodder plant on all but the prior-to-cotton fallows would help.

CONTROL OF WEEDS BY CHEMICAL WEED-KILLERS

A. LAND WEEDS.

I. Experiment FH 1.

This experiment is a continuation of that started in 1947/8, using half-subplots of cotton and dura to test the residual effect of spraying up to 8 lbs per acre Methoxone in 1947. Observations were also made prior to the dura and cotton sowing, to determine any persistence of effect on the weeds.

(a) Weeds.

Mean percentage weed cover.

Treatment	Date of observation	Land sprayed March 1947				Land sprayed May 1947				Control	Remarks
		1 lbs/ fed	2 lbs/ fed	4 lbs/ fed	8 lbs/ fed	1 lbs/ fed	2 lbs/ fed	4 lbs/ fed	8 lbs/ fed		
Pre-dura sowing	19.7.48	—	4	3	2	3	4	4	—	3.4	Diff. not significant
Pre-cotton sowing	14.8.49	—	58	64	36	65	41	40	—	75	Significant diff. of any two means = 18.8

Selected weeds : comparison of 8 lbs/acre treatment and control means.

	8 lb/acre % cover	0 lb/acre % cover	Remarks
<i>Acalypha indica</i>	13.3	7.5	Increased
<i>Ipomoea</i> spp.	15.5	21.3	Reduced
<i>Commelina kotschyii</i>	2.3	5.8	"
<i>Heliotropium europaeum</i>	5.3	16.0	"
<i>Momordica cymbalaria</i>	2.8	0.5	Increased
<i>Phyllanthus niruri</i>	0.5	14.0	Heavily reduced.

(b) Dura (Feterita). Sown 25/7/48.

No significant differences in stand or yield of treated subplots, as compared with controls, were noted.

(c) *Cotton (X1730A)*. Sown 18/8/48.

As with dura, no significant differences occurred in either stand or yield of the crop.

(d) *General*.

The small size of subplots (6 ridges only) has seriously limited the efficiency of this experiment in both seasons; in the present season none of the differences between yields attains significance. The neighbouring ridges of dura seem to have had some effect in sheltering the cotton.

II. *Experiment FH 2.*

This was to test the residual effect of D.C.P.A. emulsion applied at 1.2 and 2.4 lbs/feddan in April and May 1947. All subplots were again sown with cotton (as a uniformity measure over the plot) and yields recorded to see if any further effects were discernible. Cotton was sown on 18.8.48.

No significant residual effect of treatment on yields could be discerned. It is concluded that there is no residual effect 1 year after spraying with D.C.P.A. emulsion, under Gezira conditions.

III. *Experiment FH 5.*

This experiment was designed to determine the effect of weed killing concentrations of Chloroxone and Methoxone on an immediately succeeding cotton crop. Subsidiary studies included observations on weeds, and on the effect on scattered seed cotton.

10 lbs of seed cotton was scattered on each subplot (1/12 feddan) to represent field debris and lightly covered with soil.

Spraying with Methoxone and Chloroxone at 1 lb. and 2 lb. per feddan was then carried out on 5.6.1948. Counts of cotton seedlings were made at intervals up to the normal time of sowing of the cotton. Estimation of weed coverage was made at the time of weeding before the entire plot was sown with cotton.

Various difficulties developed. Due to the low-lying nature of the plot, the soil became waterlogged during the rains and for 3 weeks it was impossible to observe the germination of the seed cotton; considerable washing-out and removal from sub-plot to sub-plot of the scattered seed cotton occurred.

The Methoxone and Chloroxone applications seem capable of heavily reducing germination of cotton seed such as might happen with debris-strewn land, but they do not appear capable of giving the almost 100 per cent kill required to remove the risk of blackarm disease carried by volunteer seedlings.

The reduction in weed cover, however, was appreciable, though again the apparent absence of effect on *moleita* coupled with the heavy reduction of *Phyllanthus* and other easily removed weeds reveals a possible risk of changing the flora for the worse over a period of years.

It appears that the toxic effect on cotton of dosages of Chloroxone and Methoxone up to 2 lb/feddan is lost by the end of 10 weeks, under June-mid-August rainfall conditions, and that germination is not seriously impaired by early-June spraying of these chemicals for pre-sowing weed control.

IV. Experiment FH 7.

This plot, used for a Methoxone against *Striga* on dura experiment in 1947/8, was sown with cotton throughout in 1948/9, to investigate any residual effects of the application.

Spraying dates	Dosages
15.7.47	0 lbs per feddan
5.8.47	1
21.8.47	2

The dura was watered and harvested in the normal manner in 1947 and the land then left uncropped until 17.8.48, when it was sown with cotton (X1730A). No significant differences were observed in early stand, between treatments.

On 1.11.48, three typically hormone-damaged plants were found at two separate points, but both on plot margins. No symptoms were observed on the lower leaves, and the next leaves to be formed after the damaged ones showed diminishing injury, until by mid-December, after shedding of the affected leaves, no further symptoms developed. Mean yield per dosage (k.p.f.) :—

Control	3.81
Methoxone 1 lb/acre .. .	3.31
Methoxone 2 lb/acre	3.33

The control yield is just (5 per cent level) significantly higher than the treatments.

The reduction in yield shown as a result of spray treatment the previous year is only just significant at the 5 per cent level. This may partly be due to the reduced dura yields on the control plots in the previous season, leaving a difference of fertility in the soil. Until further evidence is produced to the contrary, it is probably unsafe to assume that there was no residual effect of the Methoxone.

The "symptoms" of hormone injury—distorted strap-like leaves with frilled edges and almost completely trifoliate, found in November, may not be due to the previous year's treatment, for they have been found on cotton growing far from any sprayed area, on land used as a latrine area by villagers. As b-indole-acetic acid occurs in urine it is possible that many observations of "hormone injury" on and near sprayed plots may be due to this and must be treated with reserve.

V. Control of Tugur (*Pulicaria crispa*).

For some years tugur (*Pulicaria crispa*, Benth. & Hook. f.) has been reported to be spreading in the Gezira, particularly in the north

and west. Most of the plants are annual in the Gezira, but a considerable number are perennial and survive by means of deep roots. The weed grows to about 2 ft. high, is woody with a strong tap root, and is very difficult to kill, without individually hoeing each plant. The plant sets many seeds which are wind-carried, numerous seedlings coming up each year on infested land. (Hand weeding is unpopular because it is thought to be responsible for a form of dermatitis).

It appeared that chemicals might in the long run be the cheapest and most effective way of controlling or eradicating this weed, and an experiment was arranged with the Sudan Plantations Syndicate on a badly infested area in Wad el Bur Block.

The site of the experiment was the first angaia of Wad Matar 20 F, which was fairly heavily infested, and uncultivated prior to lubia sowing. The area was divided into 30 plots of equal area (approx. 1/46 feddan), and sprayed with 3 strengths each of 3 different proprietary chemicals of the "hormone" type. These were Methoxone, Chloroxone and Phenoxyl.

The strengths used were equivalent to 1 lb, 2 lb, and 4 lb. of active agents per feddan. Treatments were carried out on 4.6.48 before the main rains and observations were carried out monthly as from 22.7.48.

The mean numbers of *tugur* plants per treatment, on four different dates of observation, were as follows:—

Treatment lbs/feddan	Control	Methoxone			Chloroxone			Phenoxyl			Significance
		1	2	4	1	2	4	1	2	4	
Date											
22. 7. 1948	68	32	32	4	4	3	1	7	43	18	sig. at 5%
27. 8. 1948	68	21	20	1	3	0	0	39	23	4	not quite 5%
30. 9. 1948	69	35	20	2	2	0	4	35	19	5	" " "
9. 12. 1948	56	23	23	1	3	1	0	31	17	4	" " "

The results show very clearly the superiority of Chloroxone as a weed-killer on *tugur*. The plots when first sprayed except for the *tugur* only showed the lightest of weed cover. No *tugur* plants were seen to exhibit the distortions which characterise the effect of these weed killers on so many plants.

On the last date (9.11.48) of observation of the *tugur*, most of the other weeds were dead or moribund, with the exception of a few scattered *Crotalaria saltiana*. There was a suggestion (but no more) that weeds remained green longer on treated plots.

Effect on subsequent crops.

When the remainder of the field was sown with lubia, it was decided to test what residual effects, if any, were apparent over the treated plots. Accordingly, each plot was divided into two halves, and sown half-cotton (X1730A) half-lubia, 66 holes of each, on 20.11.48.

Germinated holes were counted, lubia on 29.11.48 and cotton on 6.12.48. There were no significant differences in stand of either crop.

The cotton was kept watered until 23.1.49 in an effort to estimate residual damage from the hormone spray. On this date, the lubia was also examined.

No differences were found in the lubia. The cotton was then examined for the characteristic distorted leaves of hormone injury. None of the plots contained more than 2.5 per cent of injured plants, even at the highest concentrations. Chloroxone appeared the most injurious of the three chemicals, but even at the highest rate it caused negligible injury to the cotton plants.

Finally, among the sprinkling of weeds coming up in the crop, the young *tugur* were counted. Totals (over 3 subplots) per treatment were :—

	Methoxone	Chloroxone	Phenoxy
1 lb/acre	8	7	9
2 lbs/acre	8	3	25
4 lbs/acre	4	8	13

Control 11

It cannot therefore be claimed that any lasting reduction in *tugu* infestation has been brought about, except that as all perennial plants were weeded before the sowing of the crops, the reinfestation must have been from the ubiquitous drifting seeds.

B. WATER WEEDS.

I. *Darwish Experimental Canals.*

The twelve canals of this series were treated at the end of April 1948, with such quantities of weed killers as would give 8 p.p.m. of Methoxone or Chloroxone in the water. Each branch canal was blocked in the middle, to give 2 portions of 25 metres, and the distal portion left as "summer closed" to dry out. The proximal portion was left open at the end joining the supply canal.

Observations were made on the water-filled portions at intervals of 7 days to study the effects on growth of the water weeds, and at the appropriate times the banks of the proximal portion were breached in order to water plots of dura and cotton on the adjacent land. After running these water residues on to the land, the blocks were broken, and a further plot of land watered through the "summer closed" distal section. These plots, too, were then sown with the appropriate crop.

To prevent undue admixture of the contents of the various branch canals during early dura watering, all were blocked at the head immediately before watering, and the blocks breached as required when watering commenced.

On 23.4.48, solutions of sodium salts of Methoxone and Chloroxone were sprayed on the water. The water was sampled on 4.7.48 and 250 ccs. of water from each canal were used for watering dishes sown with dura seed : all dura seed germinated and grew normally and it was concluded that the treated water at that date would have no bad effect on dura germination.

Water weeds when observed on 4.7.48 were not so heavily affected by the treatment as they were in the previous year, and subsequent observations throughout the 1948/9 season confirmed this.

The treatment effect, fairly well-marked on June 13, was lost progressively as the season advanced. It would appear that part of the loss of effect of the treatments is due to dilution of the treated water on account of this open connection with the supply canal, and possibly a part also to a difference in efficiency between the powder used in 1947 and the liquid used in 1948. This question of efficiency is borne out also by observation of the summer-closed sections of canals after refilling, which showed on 30.11.48 mean infestation of :—

Controls	70%	blockage with weeds
Methoxone	20%	„ „ „
Chloroxone	32.5%	„ „ „

The canal treated with powder in 1947 showed no weed recovery or regrowth.

Crops grown on land watered from treated canals.

Canals A, F, G, H, J were used for watering dura plots ; the rest for cotton plots.

At dura sowing time all canals were blocked at their junctions with the supply canal, and the banks of the full sections breached to allow treated water to run on the land. The areas covered by this treated water were then mapped on graph paper. The block was then broken and the remaining water in the canal flushed to water completely half the plot. The central block was then breached so as to fill the summer- closed section, and the second half plot watered with water drawn through all the treated canal. Dura was then sown.

At cotton sowing time the same procedure was followed with the remaining canals.

Germination counts of seeds per hole were made and no significant differences were found between the plots or between 1st. water and 2nd. water halves of each plot.

Owing to pressure of work the dura was harvested without weighing. The yield appeared excellent and no differences in vigour of the crop were noted with treatments.

Cotton yields in k.p.f. were as follows :—

			Methoxone	Chloroxone	Control
Proximal	Plot I	6.40	5.75	5.85	7.75
	Plot II	5.05	5.39	5.57	5.42
Distal	Plot I	5.27	5.82	4.86	6.57
	Plot II	6.36	6.03	5.45	5.20

No significant differences.

The high but irregular yields can be explained by the fact that a fertility gradient runs from end to end of the supply canal system, coupled with the fact that the plots themselves are not completely level, and that this was the first crop borne by the ground for many years.

The results as regards weed killing effect were not as satisfactory as in 1947/48 and many water weeds survived, especially in the "summer open" canal sections. This may be due to various causes, the most likely being that in the present season the chemicals were added as solutions of their sodium salts. Last year a powder (CLC 1 per cent), containing 1 per cent Methoxone in a base consisting of calcium carbonate or other calcium salt which turns to carbonate on exposure to the air, was dusted on to the canal water. As the calcium salts of these weed killers are known to be less soluble than the sodium ones, it is possible that the effect of the sinking dust on the water weeds was like an "underwater spray" rather than a soaking in a dilute solution, as in this season, and the weed killer applied as a dust was at first concentrated on the plants, before later passing into solution. Further experiments are in progress with different formulations.

II. Control of *Chara fragilis* by copper sulphate.

Chara fragilis is becoming increasingly plentiful in the Gezira canals and, owing to the fact that it is heavier than water and that it lines the bed of the canal, this alga is very difficult to clear; it makes its most active growth during the period January to March.

The following experiment was carried out this season on Ramadan Minor Canal, 3rd reach, using sufficient copper sulphate to provide concentrations of 10, 20 and 30 parts per million in the canal water in 150 metre sections of the reach. Application was by spraying a 20 per cent solution of copper sulphate from knapsack sprayers. The application was carried out on 2.2.49 and observations continued until 3.3.49.

The following conclusions were reached :—

- (1) 10 p.p.m. was not very effective, and new growth of *Chara* was noticed.
- (2) 20 p.p.m. was effective; the *Chara* was apparently all dead, and no new growth was noticed; the copper appeared also to have damaged the *Chara* in the control water immediately downstream of the treated section.

- (3) 30 p.p.m. was effective, but in at least part of this reach, the original amount of *Chara* was less than the control and it was not easy to decide if the treatment was better than 20 p.p.m.

C. CONTROL OF STRIGA.

Effect of Previous Lubia Crops.

This experiment on plot 30 was designed to test the effect of previous crops of lubia on *Striga* infestation on the succeeding season's dura. This plot was divided into 30 subplots of 1/6 feddan each. 15 subplots were sown with lubia in the seasons 1946/47 and 1947/48 whilst the remainder were fallowed.

The lubia was sown on 9.12.46 and on 17.7.47 and harvested on 23.4.47 and on 27.12.47.

On 26.7.48 the whole field was sown with Feterita dura, 10 seeds per hole, at 50 cms spacing. Resowings were made as necessary.

(a) *Striga*.

Infested holes counted on 25.9.48. Average per subplot :—

After fallow	After lubia
324.5	361.1

These differences are not significant.

Green weight in kilos of *Striga* plants pulled on 11.10.48: as averages per subplot :—

After fallow	After lubia
3.77 kilos	5.20 kilos

These differences are also not significant.

Though none of these *Striga* figures attains significance it is noteworthy that both tend to show a heavier degree of aerial infestation after the lubia crop.

(b) *Dura Yields.*

	After fallow	After lubia	Significance
No. heads/feddan ..	30,978	31,086	N.S.
% ripe heads in total	63%	79%	x x
Wt. heads (r.p.f.) ..	1,850	2,405	x x
Wt. ripe heads (r.p.f.)	1,771	2,326	x x
Wt. gassab (r.p.f.) ..	7,414	8,445	x x
Ratio heads : gassab	0.239	0.275	x x
Grain (sheishna)*			
(r.p.f.) ..	1,074	1,380	

* Estimate from samples

A point worthy of notice is the percentage of ripe heads, which is indicative of more rapid maturity of dura following lubia, less *Striga* infestation also producing the same result.

The experiment cannot be said to have demonstrated any effect of the lubia on *Striga* infestation, for a comparison of the results with those obtained from nitrogen manuring shows such a similarity that it is difficult to avoid the conclusion that increased fertility alone may have brought about the observed result. (The comparison extends even to the head/gassab ratios and the "maturity" ratio of "per cent ripe heads"). To obtain conclusive results subplots containing no *Striga* seed in the soil would have to be included in the experiment, but these were not available in Plot 30. It is suggested that the results obtained are caused by two factors:—

- (1) The lubia has increased the fertility of the soil above that obtained by one year's fallow and the dura has consequently produced a more extensive root system which has permitted the plant to cope more easily both with its own and the parasite's nutritional requirements. It is an established fact that more aerial *Striga* is often produced when dura is growing on lightly infested soil than in heavily infested soil, though the effect on the dura is of course much greater on the latter soil than on the former.
- (2) The quantity of *Striga* seed in the soil of Plot 30 is so great that several crops of lubia may be necessary in order to destroy an appreciable amount of the seed.

D. EFFECT OF METHOXONE AS A POSSIBLE GROWTH STIMULANT.

In view of the increased yields obtained last season on Plot 81 following weed-killer treatment, which seemed to be due to causes other than reduction of weed growth, an experiment was carried out on Plot 77 in order to determine if minute applications of Methoxone could benefit a cotton crop under normal conditions of treatment.

Three strengths of Methoxone, two sowing dates, and two types of application *viz.* on the ground immediately before sowing and on the plants approximately three weeks after sowing, were applied at the standard rate of 100 gallons per feddan.

The last picking of the crop was made on 7.4.49, with the following results:—

Mean total yields per treatment.

Strengths.				k.p.f.	
Control ..	..	..	..	3.64	
0.1 p.p.m.	..	..	..	4.11	diff. not significant
0.2 "	..	..	..	3.91	
1.0 "	..	..	..	3.77	
<i>Sowing dates.</i>					
Early sown	17.8.48	..	..	4.20	
Late sown	2.9.48	..	..	3.52	diff. not significant
<i>Spray application.</i>					
On plant	..	..	..	3.84	
On ground	..	..	..	3.88	diff. not significant
Mean Control yield, k.p.f. =					3.64
" 0.1 p.p.m. " " =					4.11

As there had been an indication of earliness in the treated subplots, the first three pickings of cotton from the early-sown subplots were considered separately, with the following results :—

Total cotton picked up to 10.2.49.

Control	..	..	..	..	2.66	k.p.f.
0.1 p.p.m.	..	..	..	..	3.17	„
0.2	„	..	..	..	2.66	„
1.0	„	..	..	..	2.51	„

Minimum significant difference of any 2 means = 0.44 k.p.f.

A just significant increase of early cotton has therefore occurred under the treatment. It is unfortunate that grade data are not available, but since the higher grades tend to be found in the earlier pickings it is possible that an increased proportion of the higher grades may be obtained by spraying with these extreme dilutions of Methoxone.

METHOXONE AND BAD BOLL OPENING.

Investigations were made on all experiments of this section where hormone weed-killers were used to see if treatments had any effect on the incidence of badly opened bolls. No significant effects were found.

B. Plant Pathology

by

S. A. J. Tarr.

I. PLANT DISEASES IN THE GEZIRA.

1. BLACKARM ON COTTON.

Causal organism—*Xanthomonas malvacearum* (E.F.S.) Dowson

This disease was light in most places and can have caused little overall damage : scattered patches of heavy infection were reported. The varietal trial plots at Hag Abdullah, Turabi and the G.R.F.

showed considerable primary infection and there is little doubt that this was due to imperfect Abavit dusting of the sowing seed: fortunately there was but slight spread of the disease from these plots to adjacent commercial cotton. An outbreak attributed to similar causes occurred with seed of the same origin sown in the Kassala area of the Gash Delta. A system of seed certification is now being put into operation and in this way it is hoped to prevent similar occurrences in the future. Inspections carried out at the Barakat Seed Farm in September and October, 1948 indicated that blackarm was unusually light, much more so than in 1947. This may be attributed, in part at least, to the fact that this year all the sowing seed used at the Seed Farm was liquid disinfected by steeping in mercuric chloride-iodide solution. (See page 55). Blackarm in the Gash Delta was very light in 1947-8 and the commercial sowing seed was treated with Abavit B. Hence it is probable that, apart from possible "ginny infection", primary seed-borne blackarm in the commercial crop (with the exception of the Barakat Seed Farm, some of the sowing seed for which is not "filtered" through the Gash Delta) was small. The main source of blackarm infection for the commercial Gezira crop appears to have been in the form of infected cotton debris and self-sown seedlings.

2. LEAF CURL OF COTTON.

Caused by cotton leaf curl virus (*Gossypium Virus* 1 Farquharson).

A few heavy patches of leaf curl were reported in October and November 1948 but in general the disease caused no serious loss of crop. Whitefly (the vector of cotton leaf curl) appeared to be more numerous than usual this season, and this was reported to have been particularly so in certain areas which had been DDT sprayed against Jassids. Observations made in Wad Saadalla Block indicated that leaf curl was very slight indeed in late November (see page 55).

3. FUNGAL WILT, BOLL ROT AND SOOTY MOULD OF COTTON.

Cladosporium spp. and *Alternaria* spp. have not been reported as serious anywhere in the Gezira this year.

4. DEFECTIVE BOLL OPENING OF COTTON.

A condition of cotton characterised by premature boll opening, poor grade cotton, leaf shedding and a general drying out of the terminal buds was examined on cotton areas in the Gezira and White Nile Schemes. There was no reason to suppose that it was parasitic in nature.

5. SMUT OF DURA.

Covered (common) smut caused by *Sphacelotheca sorghi*, (Link)

Clint. was seen on some native cultivations. It can be controlled, effectively and cheaply, by seed treatment with copper carbonate.

6. ANTHRACNOSE OF DURA. Caused by *Colletotrichum graminicola*, (Ces.) Wils, was found but was of little importance.

7. BACTERIAL BLIGHT OF LUBIA. = *Bacterial blight*

Caused by *X. phaseoli*, (E.F.S.) Dowson. Considerable spread of this disease occurred among lubia sown early in places of heavy early rains. The late sown crop suffered little damage.

8. LEAF CURL OF TOMATO. As usual, this virus disease was widespread in some gardens and must have occasioned some loss of crop.

9. MILDEWS.

The most frequent were *Liveillula taurica*, (Lev.) Arn., *Sphaerotheca fuliginea*, (Schlecht.) Poll. and *Erysiphe cichoracearum*, DC. They were widespread on many vegetables, in particular bamia (*Hibiscus esculentus*, L) and egg-plant (*Solanum melongena*, L.). They were not observed on cotton.

II. PLANT DISEASES AT THE GEZIRA RESEARCH FARM.

I. BLACKARM ON COTTON.

This disease caused considerable damage to some plots this year. This was particularly so in the southern part of the farm. Blackarm was first seen on 31st. August (18 days after sowing) in Plot 261 (cotton varietal trial) and undoubtedly arose from seed infection. The same applies to the American cotton (*G. hirsutum*, L.) in Plot 22 (seed from Nuba Mountains). Date of first observed appearance on newly sown cotton (as distinct from volunteer seedlings) in previous years was 8th. September 1947 (Plot 4), 1st September 1946 (Plots 2, 3 and 4) and 22nd. September 1945 (Plot 3). 1948 rainfall was favourable to spread of the disease and certain susceptible varieties of cotton in Plot 261 suffered severely. Infection of nearby plots also took place by driving rain and (probably) by windblown infected cotton debris.

July and September rainfalls were heavier than usual at the G.R.F. this year and the latter was responsible for considerable spread of blackarm from the primary infection in Plots 261 and 22 where imperfectly Abavited seed had been sown.

2. LEAF CURL OF COTTON.

Leaf curl was first seen on 9th. October 1948 (Plot 57) as compared with 1st. November 1947 (Plot 207), October 8th. 1946 (Plots 66, 227) and October 8th. 1945 (Plot 98). Whitefly appeared to be very numerous this year but no serious outbreak of the disease was reported.

Observations made in mid-March 1949 indicated that leaf curl has not been so widespread this year as in 1946-7 and 1947-8, the percentage infection being considerably less in most plots examined. The disease has not been responsible for any serious loss of crop at the G.R.F.

3. LEAF CURL ON OTHER MALVACEAE.

Leaf curl on bamia (*Hibiscus esculentus*, L.) was observed in several G.R.F. gardens in mid-November 1949 but no bamia was found during the months in which its cultivation is prohibited.

4. WILT OF COTTON.

Fungal wilt was reported from a number of plots this season and appeared to be more prevalent than in 1947-8.

5. BOLL ROT OF COTTON.

This was not observed.

6. SOOTY MOULD OF COTTON.

A few cases were seen but caused little damage.

7. DURA SMUT.

Only rare cases of covered smut on dura were seen except in smut experiments. All G.R.F. sowing seed (dura) is dusted with copper carbonate. A few specimens of loose smut (*Sphacelotheca cruenta*, (Kuehn) Potter) on wild *Sorghum* spp. were noted.

8. ANTHRACNOSE (*Colletotrichum graminicola*, (Ces.) Wils.) was not uncommon on leaves of young dura but caused negligible damage.

9. BACTERIAL BLIGHT OF LUBIA.

Early sown (July) lubia suffered quite heavily from this disease : the rainfall this year facilitated its extensive spread. Considerable leaf shedding resulted and in many cases the disease spread to the stem, producing typical lesions. The later sown crop suffered only slight attack. First date of observed appearance was 21st. August 1948, as compared with 23rd August 1947. Bacterial

diseases were also noted on soya (*Glycine max*, (L) Merr.) and on cowpea (*Vigna unguiculata*, (L.) Walp.).

10. SOOTY MOULD OF LUBIA.

Cladosporium spp. and *Alternaria* spp. following asal (probably due to whitefly). This did not appear to be as common as in the previous season.

11. WILT OF LUBIA.

Macrophomina wilt, associated with *Macrophomina phaseoli*, (Maubl.) Ashby, was quite extensive on certain plots. The overall damage caused by this fungus was, however, probably slight. Similar wilting was occasionally observed on cowpea and on haricot beans.

12. CURLY TOP OF HARICOT BEANS (*Phaseolus vulgaris*, L.).

This condition, probably of a virus nature, was observed in many G.R.F. gardens.

13. NEMATODES.

Occasional cases of eelworm-infected vegetables were seen, in particular on tomatoes at Khartoum. They caused little damage at the G.R.F. this season.

III. PLANT DISEASES IN OTHER PARTS OF THE SUDAN.

I. THE GASH DELTA.

Observations were made on the occurrence and leaf curl infection of ratoon cotton in last season's cotton fields in the Gash Delta (September 1948). Detailed results are not given here. In general ratoon growth was much less than in September 1947 due partly to better pulling in 1948 and also to abnormally low 1948 rainfall in some areas of the Gash Delta. No leaf curl infected Sakel ratoons in the second rotation (late sown) Sakel fields of 1947-8 were found but the average leaf curl in the first rotation (early sown) Sakel fields was found to be 48 per cent. Much bamia, heavily infected with leaf curl, was found on sagias in the Kassala area, where the vegetable is cultivated continuously under irrigation throughout the year.

An inspection with a view to estimating blackarm and leaf curl infection in the new 1948-9 Gash cotton crop was carried out in November-December 1948. Blackarm was found to be very light this year although rather heavier than in 1947-8: this may perhaps be associated with the fact that certain areas of the Barakat Seed Farm in 1947-8 were fairly heavily infected with blackarm and much of the Gash 1948-9 sowing seed originated from the 1947-8 crop of the Barakat Seed Farm. Second rotation cotton appeared to show less blackarm infection than that of the first rotation; this is to be expected in that the former is sown at a time when the rains have ceased. Severity of attack was in most cases low.

Very few stem or boll lesions were observed, except in cotton in the Kassala Banana Scheme where a heavy infection of blackarm was found in the leaf curl resistant Sakel cultivated on a plot of land in this Scheme. There is little doubt that this was primary seed infection due to imperfect disinfection of the sowing seed: similar seed sown in certain parts of the Gezira also showed this primary infection (See pages 47 and 49). Seed from this LCR Sakel (and especially the early pickings) will almost certainly be contaminated with the blackarm organism.

The inspection for leaf curl indicated that this disease was much less serious this season than in the previous one. This was thought to be associated with three factors (1) With a single exception (Illibilli 1-2) all the Sakel was late sown and it has been noted in previous years that late sown (second rotation) Sakel in the Gash Delta tends to suffer much less leaf curl damage than that sown earlier (first rotation). The reason for this is not known but it has been suggested that it may be associated with the supposedly greater numbers of whitefly at the earlier sowing date. It is significant that the only early sown Sakel in the Gash Delta this season suffered heavy leaf curl attack whilst all the second rotation Sakel fields were but lightly infected. (2) As reported above ratoon growth was found to be considerably lighter this year than last. This indicates that fewer sources of leaf curl infection were present in the Delta (3) The whitefly population on cotton in the Gash Delta is thought to have been lower than usual this season. The reasons for this alleged low infestation are not known; climatic factors (*e.g.* rainfall) may have been partially responsible.

2. GEDAREF.

A visit was paid to the Mechanised Crop Production Scheme in the Gedaref area. Specimens of dura seedlings suffering from "Camp 8 disease" were examined. No evidence that this condition is parasitic in nature was found. The leaves of "diseased" seedlings assume a paler colour, very often with whitish streaking. The plant becomes limp and tends to wilt, in many cases dying. Root development appears to be weak and the mesocotyl dies off prematurely, thus cutting off the aerial part of the very young seedling from the nutriment still remaining in the seed. The impression was gained that the condition was in some way associated with the amount of available moisture in the soil. It may be that, with the present method of sowing, the seed is not sown deeply enough and that, after sowing, the soil is not pressed down sufficiently over the seed with the result that the young seedling finds itself in a loose seed bed and with inadequate water. It has been reported as worst on land which has been under more or less continuous cultivation and on land recently disced. This suggests that the condition may in some way be associated with deterioration of soil structure. "Camp 8 disease" is not something which has arrived with the M.C.P. Scheme, since it has been known by native cultivators in the area for several years. Local cultivators are said to associate the condition with heavy rains and say that its effects are worse on land under continuous cultivation than on *harig* land. It has been observed that dura on weedy land is usually free from the

“disease” but that it is prevalent on clean land or in low lying areas. For this reason local cultivators advise strongly against weeding dirty land when the dura is in the seedling stage.

3. YAMBIO.

In December 1948 a few weeks were spent at Yambio (Equatoria). During that time the poor germination of certain cotton seed in Equatoria was investigated in cooperation with the Agronomist. From experimental work and observations on the cotton sowing date experiment it was found that early picked cotton showed a higher proportion of sound seeds and a better germination than that picked later in the season. This is thought to be due largely to stainer bugs attacking the seeds in the open bolls. A report on this work is given on page 182.

The problem of periodicity in Tung (*Aleurites* sp.), its suggested association with cankers caused by *Megalonectria pseudotrichia*, (Schw) Speg. (= *Thyronectria pseudotrichia*, Speg. Seeler) and future lines of investigation were discussed with the Senior Research Officer, Yambio. This problem is concerned with the growth cycle of the tung tree with especial reference to the times of leaf shedding, blossoming and fruiting. It is of importance because the “heteroperiodic” trees undergo a definite leaf shedding during the rainy season and—presumably associated with this—are smaller and yield much less than the “orthoperiodic” trees which are in leaf throughout the year.

Many specimens of plant diseases were collected and examined. A preliminary list of some of these not hitherto recorded from the Sudan is given in the Appendix, page 63.

IV. EXPERIMENTAL WORK

BLACKARM DISEASE OF COTTON.

A. Disinfection of cotton seed against *X. malvacearum*.

Efforts to find a more efficient seed treatment than Abavit B are being made. The main conclusions from 1948-9 trials are summarised below.

1. Increase of mercury content¹ of Abavit B. powder.

Commercial Abavit B, as used for treating cotton seed in the Sudan, contains about 5.67 per cent mercury as mercuric chloride and iodide. Stronger powders were made up by adding the appropriate amounts of these mercury salts. It was found that the powders containing 11.2 per cent and 8.4 per cent mercury were more effective than that containing 7.0 per cent mercury and all were more effective than ordinary commercial Abavit B. Whilst the latter is satisfactory for the bulk of the Gezira sowing seed (which comes from the Gash Delta and usually carries very little blackarm infection), a stronger (8.4 per cent mercury) Abavit might well be used in places where more heavily infected seed has to be sown (e.g. in parts of the Barakat Seed Farm).

2. *Increase of Abavit dosage on the seed.*

Using commercial (5.6 per cent mercury) Abavit B powder at different dosages it appeared that 1:75 and 1:100 of Abavit B to cotton seed by weight were more effective than the normal 1:150 dosage, and the latter more effective than a 1:300 dosage. The quantity of Abavit powder which cotton seed will take up depends on the amount of lint and fuzz present. In actual practice commercial cotton seed will not normally hold a greater dosage than about 1:150—if given a heavier dosage the excess powder is shaken off in transport and handling before the seed is actually sown. Since it is probable that the Abavit powder does not kill the blackarm bacteria until moistened by soil water after sowing it is apparent that this method is not as promising as that of increase in mercury content of the Abavit powder. In this experiment the seed was not subjected to the handling and transportation which Gezira sowing seed receives and was as a consequence able to hold a heavier dosage of Abavit.

3. *Other dry (powder) dressings.*

Several dressings were used at the rate of 1:150 to cotton seed. A dressing containing 30 per cent tetramethyl thiuram disulphide (supplied by Messrs. I. C. I. Ltd.) gave some control as also did Perenox powder (50 per cent copper as cuprous oxide, an I. C. I. product), but both were much less effective than Abavit B. A mercury iodochloride dressing similar to Abavit B, and supplied by F. W. Berk & Co. Ltd. appeared to be almost as effective as Abavit. Agrosan GN (an I.C.I. product containing 1 per cent mercury in an organic form) was not nearly as good as Abavit B—this is understandable since it contains less than one fifth the mercury content. It is hoped to test a stronger Agrosan next season.

4. *Slurry treatments.*

Two experimental viscous aqueous mercurial dressings supplied by Messrs. I.C.I. Ltd. were tested. Each contained inorganic mercury, one as mercuric chloride and the second as mercuric chloride-iodide mixture. They were designed to be used in the form of a small volume of concentrated aqueous suspension which would dry quickly on the seed—as in the “slurry” method of seed treatment. Such a treatment should have an immediate killing effect on the seed borne blackarm bacteria as well as providing a residual protection. With the mixing method used a preliminary experiment indicated that this slurry method, although possibly applicable to delinted cotton seed, is not likely to be suitable for ordinary ginned commercial cotton seed which carries with it a considerable quantity of fuzz and cotton fibre. Further trial of this will be carried out.

5. *Steeping treatments.*

The most effective method of cotton seed disinfection yet found is by steeping the seed in a 0.2 per cent solution of mercuric chloride-iodide (4:1) for two hours followed by quick drying. A similar steeping using an equivalent concentration of ethyl mercuric phosphate

(supplied by Messrs Boots & Co. Ltd.) indicated that this substance might be as effective as mercuric chloride-iodide. Steeping in 10 per cent Perenox suspension afforded some control but little in comparison with mercurials.

6. *The effect of addition of certain dyes to Abavit B powder.*

Experiments on dyeing cotton seed various colours have been carried out by the Soil Research Section with the object of easier identification of different varieties of seed. The process adopted has been to mix a known quantity of the dye with the Abavit B powder used to disinfect the cotton seed. A preliminary experiment to determine whether the addition of such dyes would adversely affect the bactericidal properties of the Abavit B suggested that such was the case with certain of the dyes tested.

B. *Liquid Disinfection of the sowing seed for the Barakat Seed Farm.*

The whole of the 1948-49 sowing seed for the Barakat Seed Farm was liquid treated by this section during March and April 1948. 193 sacks of cotton seed were treated in four household baths with 1:500 solution of mercuric chloride (4 parts) and mercuric iodide (1 part). This task occupied six weeks and it was calculated that—using this method—an average of about 270 ccs of solution were used per lb. of cotton seed.

An inspection carried out three to four weeks after sowing at the Barakat Seed Farm failed to detect any blackarm in the 46,000 holes of cotton examined. The results indicated that the liquid treatment had greatly reduced seed-borne blackarm infection.

C. *The flooding of certain 1947-8 cotton areas at the Barakat Seed Farm.*

This work was carried out with the object of ascertaining whether the flooding of the previous season's cotton fields perceptibly reduced their blackarm infectivity to the new crop. The results indicated that such flooding of old cotton fields does tend to reduce their infectivity. The relatively slight overall blackarm in the numbers examined rendered the results less conclusive than had been hoped. In a heavy blackarm year it is possible that such large scale flooding of old cotton land at the Seed Farm would be worth while, but in a year of light infection such would not be the case.

LEAF CURL OF COTTON.

A. *Transmission Experiments Between certain Malvaceous Weeds and Sakel Cotton.*

Sida alba, L. (= *S. spinosa*, L.). In July 1948 a few *Sida alba* plants with slight but unmistakable leaf curl symptoms were noticed in Wad Medani. Transmission experiments from these plants to Sakel cotton, X1730A cotton and bamia were carried out in September 1948. In all cases the experiments were performed under insect proof cages, using uninfected whitefly bred for the

purpose. Transmission to Sakel was obtained in one experiment out of nine. No transmission to X1730A cotton (2 experiments), bamia (6 experiments) or *Sida alba* (7 experiments) was obtained. Extensive search was made for *Sida* plants showing leaf curl symptoms but only an occasional one was found in the Wad Medani district, none was found at the G.R.F. and none was seen in the Gezira. Such plants have however been reported occasionally from the Gash Delta. It appears that the disease is in fact transmissible from infected *Sida alba* to Sakel cotton, but only with extreme difficulty. This, together with the apparent rarity of infected *Sida* plants, suggests that this weed is not an important means of carry-over of the cotton leaf curl virus.

Senra incana, Cav. This Malvaceous plant was observed quite frequently in the Wad Medani district during 1948. It is a perennial weed and although not observed to show leaf curl symptoms it was decided to ascertain whether it could carry and transmit the cotton leaf curl virus. The results indicated that *Senra incana* is immune or highly resistant to cotton leaf curl and that under the conditions of this experiment it did not act as a symptomless carrier of the disease. A search was made for wild *Hibiscus* spp. showing leaf curl symptoms in the field but none was found, although *Hibiscus* spp. (and especially *H. ficulneus*) plants were abundant. *Acalypha* sp. (Euphorbiaceae). A number of *Acalypha* sp. plants were observed in a field of the Gezira Research Farm in August 1948. An occasional plant showed symptoms somewhat similar to those of cotton leaf curl. Transmission experiments to Sakel cotton and to healthy *Acalypha* using whitefly were carried out but in no case was transmission obtained. However the *Acalypha* plants did not take kindly to transplanting into pots: they made only poor growth and died shortly afterwards.

B. Transmission Experiments from Infected X1730A Plants.

These experiments were designed to determine whether the leaf curl resistant X1730A cotton can act as a symptomless carrier of cotton leaf curl. During the course of this work one X1730A plant developed slight but unmistakable symptoms of leaf curl. Transmission experiments from this plant to Sakel plants were performed using whitefly; in only two experiments out of twenty nine was positive transmission obtained. These results indicate that transmission of leaf curl from infected X1730A to Sakel is extremely difficult. Previous work in 1947 had indicated that symptomless X1730A plants which had been exposed to whitefly carrying the leaf curl virus were not able to transmit the disease via whitefly to Sakel. It seems that the X1730A plant—although possibly carrying the virus—is not able to transmit it to Sakel via whitefly until such time as symptoms of the disease appear, and even then can transmit it only with considerable difficulty.

C. Seed Transmission of Leaf Curl in Bamia.

In the past no experimental evidence of the transmission of leaf curl through cotton seed has been obtained, despite considerable investigation. Early in 1948 seed, hand picked from bamia plants severely infected with leaf curl, was collected. During August—September 1948 some eighteen hundred plants were grown under

insect proof conditions from this seed. In no case was a leaf curl infected plant found upon inspection six weeks after sowing. It is probable that transmission of the virus through bamia seed must be extremely rare or non-existent.

D. Transmission of Leaf Curl to Sakel and XI730A Cotton under various Environmental Conditions.

A preliminary experiment to determine the effect of environmental conditions on the development of leaf curl in Sakel and XI730A cotton was carried out. Plants of these two varieties were inoculated with whitefly taken from infected Sakel plants. The first series of inoculations was carried out in late September—early October, the second set a month later when temperatures were lower.

The results demonstrated that XI730A appears to be more susceptible to leaf curl late in the season (November) than earlier (late September and early October). This has been observed on former occasions with late-sown XI730A at the G.R.F.

E. Observations on Cotton Leaf Curl Incidence and Distribution in Wad Saadalla Block.

These observations were initiated in the 1945-6 season with the object of studying the seasonal carry-over of leaf curl in a typical Sakel-growing Block in the central Gezira. In particular the possibility of there being some undetected source of infection for the newly sown crop each year was investigated. Special efforts were made to remove as much ratoon growth as possible within Wad Saadalla Block before the new crop was sown: the incidence of ratoon growth in adjacent blocks was mapped and finally the distribution and incidence of the disease in the new crop within Saadalla was estimated (21 November—5 December). These observations were carried out each season from 1945-46 to 1948-1949. A summary of results and conclusions is given below:—

LEAF CURL INSPECTION, WAD SAADALLA BLOCK.

Summary of results, 1945-1948.

21 Nov.—11 December

	1945	1946	1947	1948
Total number fields examined	66	137	127	129
% Leaf curl infection	No. of fields.			
0 — 1%	6	29	75	118
2 — 5%	19	56	43	10
6 — 10%	13	17	4	1
11 — 15%	10	19	1	0
16 — 20%	2	7	2	0
21 — 25%	5	6	0	0
26 — 30%	4	3	1	0
31 — 40%	4	—	1	0
41 — 50%	2	—	0	0
over 50%	1			
Average % infection throughout the Block	11.1	7.5	2.2	0.57

Leaf curl infection was extremely slight in November—December 1948 there being only occasional patches of even light infection. The steady decrease of infection during the four seasons is noteworthy and is no doubt associated with the meticulous removal of ratoon growth, which was more thoroughly done than in other areas.

In previous years (1945, 6 and 7) leaf curl infection in Wad Saadalla had tended to be heaviest at the northern end of the Block. In 1948 it was fairly evenly spread throughout the Block, the northern end being, apparently, no more heavily infected than other parts. On Bilia canal the disease was found to be evenly distributed in 1948 whereas both in 1946 and 1947 there were indications that leaf curl tended to be heaviest at the end of the canal nearest fields in adjacent Blocks which had grown Sakel in the previous season. (*i.e.* the early fields in November—December 1947 and the later fields in November—December 1946). In connection with this it is interesting to note:—

- (a) In 1948, as in the previous years, infected ratoons were found in Saadalla Block although in smaller numbers than in 1946 and 1947.
- (b) From inspections of the adjacent blocks it appears that ratoon growth in them was very much less in 1948 than in the previous years—which suggests that they did not in 1948 constitute major sources of infection as they did in 1946 and 1947.

The even distribution of leaf curl in Wad Saadalla in 1948 suggests that the main sources of infection lay within the block itself and that little came from adjacent blocks. The fact that almost no infected ratoons were found in the October inspection of adjacent blocks supports this. Very small numbers of infected ratoons were undoubtedly present in Wad Saadalla block during August–October and these may well have been responsible for the even but very slight incidence of the disease in the new crop.

In 1946 and 1947 the case was rather different. In those years the disease was not evenly distributed throughout the block but showed signs of being to some extent associated with proximity to old Sakel areas of the former season in adjacent blocks. Ratoon growth was much heavier in the latter areas in 1946 and 1947 than in 1948. It appears therefore that sources of leaf curl infection for the new Sakel Crop in Wad Saadalla each season fall into two groups: (a) Sources within the block *i.e.* small numbers of infected ratoons (b) External sources—*i.e.* infected ratoon growth in the previous season's Sakel areas of adjacent blocks. In 1946 and 1947 the results obtained indicate that (b) was the more important source whilst in 1948 (a) would appear to be so. No evidence for the existence of any as yet undetected source of leaf curl infection was found and it is considered that the seasonal carry-over of the disease in Wad Saadalla block can be accounted for by infected cotton ratoon growth within the block or in nearby areas of adjacent blocks.

F. Ratoon Observations in Barakat Block.

Observations were made on 1947-8 cotton fields which had been subjected to various ploughing treatments by the S.P.S. Ltd. ; the effects of these treatments on consequent ratoon and volunteer seedling growth and on cotton debris dispersal were investigated. None of these treatments was as effective as the normal method of pulling as regards control of ratoon growth. They appeared to be quite effective in burying cotton debris and deserve further trial.

COVERED (COMMON) SMUT OF DURA.

Sphacelotheca sorghi, (Link) Clint. on *Sorghum vulgare*, Pers.

Experimental work included (1) The testing of various dura seed dressings against smut (2) An experiment designed to investigate the effects of sowing conditions on smut development.

1. Dura seed dressings trial.

A replicated block experiment using sixteen treatments, each replicated five times, was sown on 21st. July 1948. The seed used (Feterita 1931) had previously been mixed (1:300) with viable *Sphacelotheca sorghi* spores collected from smutted heads of the previous season. A count of smutted heads was made on 20-21 October 1948. The following dry dressings applied at the doses stated gave very good control: Copper carbonate (1:300), Perenox (I.C.I. product containing cuprous oxide, 1:300), Commercial Sulphur (1:150), finely divided sulphur (I.C.I. product YF 1159, 1:150), Spergon (1:650), Phygon (1:650), 10 per cent tetramethyl thiuram disulphide (at 1:160 and 1:480), 30 per cent TMTD and three sulphur-TMTD mixtures used at 1:300. The I.C.I. experimental dressings R2543 x 3 and R2543 x 4 gave only slight control. The TMTD experimental dressings were supplied by Messrs. I.C.I. Ltd. whilst the United States Rubber Company supplied samples of Spergon and Phygon. In this trial smut did not develop well, the control (untreated) seed giving only 2.82 per cent smutted heads. Smut does not appear to develop well on irrigated dura. It is known that the infection of young dura seedlings by *S. sorghi* depends largely on the relative vigour of growth of the germinating fungal spore and that of the seedling. In circumstances favourable to the seedling but unfavourable to the smut spores infection is likely to be low. Conversely, conditions favourable to the fungus but unfavourable to the seedling will tend to result in high infection. Dura, as grown under irrigation at the G.R.F., may fall into the first category and that grown under rain into the second category. Further trials of these seed dressings with rain grown dura will be made.

2. Smut development in relation to sowing conditions.

A replicated block experiment designed to test the effect, if any, of soil conditions at sowing time on the development of smut in dura was carried out. It was found that smut development was greatest in treatments producing the poorest stands of dura *i.e.* shallow or deep

sowing under dry soil conditions and giving the poorest yields in heads and gassab. Shallow or deep sowing under wet soil conditions gave heavier yields of heads and gassab and considerably fewer smutted heads. In this experiment the water content of the soil appeared to be more important as regards smut development than depth of sowing.

BACTERIAL BLIGHT OF LUBIA.

X. phaseoli, (E.F.S.) Dowson on *Dolichos lablab*, L.

Work on this disease was confined to (1) A trial of local lubia and an imported variety (ECR/127) from India for resistance to bacterial blight. (2) Routine observations on the incidence of the disease at the G.R.F.

1. *Trial of Local Lubia and Var. ECR/127.*

Each variety was replicated six times in a replicated block experiment. The plot was sown on 17th. July 1948. Rainfall was favourable to spread of bacterial blight. Counts of infected and total holes were made throughout the experiment, and yields of seeds, pods and aerial growth were recorded. The experiment was terminated on 14th. February 1949.

Visual examinations indicated that, whilst severely infected ECR/127 plants were by no means uncommon, the severity of the disease was usually much greater on the local lubia than on the ECR/127.

The ECR/127 lubia gave heavier yields of pods, seeds and fodder in this experiment and appears to be more vigorous and earlier maturing than the local lubia. Its resistance to bacterial blight may be due to the fact that the disease, although present, does not apparently have the disastrous effect on the plant so often found in the case of local lubia: this may be because the ECR/127 plant is of a more vigorous growth habit and can grow away from the disease more easily.

V. SOIL MICROBIOLOGY

Experimental work included investigations into (A) Seed inoculation of leguminous plants (B) The effect of various weed-killers on the soil micro-flora and nodulation of leguminous plants.

A. *Seed Inoculation of Legumes.*

Two field experiments to test whether inoculation of legume seeds with the appropriate nodule bacteria would lead to increased vegetative growth and greater yields were carried out. In the first experiment local strains of nodule bacteria isolated from root nodules of legumes growing in G.R.F. soil were used. No significant increase in yield or vegetative growth was recorded for groundnut (*Arachis hypogaea*, L.), pigeon pea (*Cajanus indicus*, Spreng), lubia (*Dolichos lablab*, L.), cowpea (*Vigna unguiculata*, (L) Walp.), lucerne (*Medicago sativa*, L.) and soya (*Glycine max*, (L) Merr.) although in

the case of soya there were indications of an increase following inoculation. Inoculated haricot bean (*Phaseolus vulgaris*, L.) appeared to be superior to uninoculated but the difference did not quite reach significance.

In the second experiment nodule development and plant weight in certain leguminous plants grown from inoculated and untreated seed were studied. In this case imported commercial cultures from the United States were used. With groundnut, lubia and cowpea no significant difference between inoculated and untreated seed were found. It is probable that—these crops being so widely cultivated—their nodule bacteria are widespread in Gezira soil and that no benefit is likely to be obtained from inoculating the seed. It is interesting to note that the nodulation of the ECR/127 variety of lubia (recently introduced from India and grown only on occasional experimental plots) was consistently somewhat less than that of the local variety which has been grown for many years at the Farm. With pigeon pea, plants grown from inoculated seed were considerably heavier and showed more extensive nodulation than those grown from untreated seed. Inoculation of soya and haricot bean resulted in extensive and significant increases in nodule formation and plant weight. Unfortunately most of the haricot bean plants were destroyed by wilt (*Macrophomina phaseoli*, (Maubl.) Ashby) before the completion of the experiment.

These results indicate the advisability of inoculating legumes newly introduced into the Sudan, or those being grown for the first time in any particular area. This is especially so in certain groups. Fred, Baldwin and McCoy in their study of the subject ("Root Nodule Bacteria and Leguminous Plants", University of Wisconsin, Study No. 52, 1932) formulate sixteen groups of legumes. The nodule bacteria within one group can form nodules with the roots of all plants within the group but not with those of species in other groups. Although recent work tends to throw a certain amount of doubt as to the distinctness of these groups there is little doubt that, as far as agricultural practice is concerned, they are of some value.

The experiments reported above indicate that soya and haricot bean do not nodulate satisfactorily in Gezira soil unless the seed is inoculated. These two plants belong to different groups (IV and VI) from the legumes which are commonly cultivated in the Gezira (*Vigna*, *Dolichos*, *Cajanus* and *Arachis*, all of which belong to group VII—as do *Acacia* spp.). Lucerne, another legume grown on a small scale in the Gezira, is placed in Group I.

From these considerations it would appear to be especially advisable to inoculate legumes newly introduced into a particular area and which do not fall into Group VII e.g. *Phaseolus* spp.

Certain other cultures of *Rhizobium* kindly supplied by the Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture, were also tested against commercial cultures in pot experiments. In no case was any considerable difference in yield or nodulation observed.

B. The effect of weed-killers on the soil micro-flora.

These experiments were initiated in 1948. If weed-killers are ever used on a large scale in the Gezira it is of importance that some knowledge of their likely effect on the soil micro-flora be available. Included in this were the effect of weed-killers on nodulation and general plant growth of a leguminous plant (*lubia*).

The first experiment involved the application of two hormone weed-killers, Phenoxyl and Agroxone, each at two doses to Gezira soil in pots. The doses were 0.1 per cent and 0.3 per cent solution at a rate equivalent to 100 gallons per acre: these two dosages were selected to be in line with what might well be normal and maximum field rates of application. *Lubia* was sown in these pots at two monthly intervals from mid-November 1947—mid-December 1948. In general it was found that aerial and root growth were retarded to various extents during the first six months but were not seriously affected by the weed-killer treatments after that time. During the first six months of the experiment all treatments (and especially the 0.3 per cent Agroxone) had an evident depressing action on nodule formation but after six months this had ceased to be detectable by the method used in the experiment.

In the second experiment various quantities of (i) Methoxone and of (ii) Chloroxone were added to soil in pots. These pots were sown with *lubia* the next day. Nodulation and plant growth data of the resulting plants were measured after one month. In all cases sound healthy seeds were selected for sowing. The treatments were: Control (untreated), and Methoxone at 0.01, 0.1, 1, 2, 4 and 8 lbs per acre. A similar series using Chloroxone was carried out.

In calculating the quantity of weed-killer to be used per pot in order to be roughly equivalent to lbs. per acre, it was assumed that the weed killer would penetrate through the top 10 cms of soil. In each case a measured quantity of weed killer solution was added to a known weight of air dry Gezira soil and thoroughly mixed. As far as possible the seedlings were thinned out so as to obtain five plants around the circumference of the pot.

Germination was not affected by the 0.01 lbs per acre Methoxone and Chloroxone. The 0.1 lbs per acre concentration did perceptibly delay germination but only slightly. The higher concentrations of both weed killers adversely affected germination, especially the Methoxone treatments. The effect of these high dosages of weed killer seemed to be two-fold: prevention of germination *i.e.* toxicity to the seed, and delay of germination with subsequent production of poor distorted seedlings. In the case of the highest dose of Methoxone (8 lbs per acre), only 17 seedlings resulted from the planting of 75 seeds.

Root development. Both weed-killers inhibited root growth more or less in proportion to their concentration in the soil: at the 2, 4 and 8 lbs per acre dosages the root systems showed very poor development in comparison with the controls.

Shoot development. This, in general, paralleled root development. The 2, 4 and 8 lbs per acre dosages of Methoxone resulted in

greatly reduced aerial growth; in the lower concentrations the reduction, although present, was not nearly as well marked. With Chloroxone the 4 and 8 lbs per acre treatments were associated with considerable reduction of shoot development, but this was not as severe as with the corresponding Methoxone treatments.

Nodule formation. The heavier concentrations of Methoxone (1 and 2 lbs per acre, and especially 4 and 8 lbs per acre) were associated with considerable inhibition of root nodule formation. With Chloroxone the 0.1 — 8 lbs per acre treatments all showed reduced weights of nodules. It is difficult to suggest what amount of weed-killer per acre would be used in the Gezira in the event of these substances being used on a large scale. It is likely that a rate of between 1 and 3 lbs per acre would be used for many purposes. It must be remembered that, in this experiment, the plants were sown almost immediately after the soil had been treated with weed killer. In practice such would not be the case, and during the interval between application and sowing the weed killer would, presumably, gradually disappear—especially so during wet weather, less so under dry conditions.

APPENDIX

A number of plant diseases and fungi not hitherto recorded from the Sudan were collected and identified during 1948-9. In most cases their identity has been confirmed by the Commonwealth Mycological Institute with whom duplicate specimens have been deposited and to whom thanks are due.

LEAF SPOTS.

Alternaria brassicicola, (Schw.) Wilts. On (1) *Brassica campestris*, L. (Turnip). Juba (2) *Brassica oleracea*, L., var. *botrytis*, L. (Cauliflower). Juba.

Cercospora bidentis, Thorp. On *Bidens pilosa*, L. Yambio.

C. cucurbitae, Ell. & Ev. On *Cucumis sativus*, L. (Cucumber) Torit.

C. sp. (close to *C. columnaris*). On *Dolichos lablab*, L. Juba.

C. sp. (close to *C. solani-torvi*). On *Solanum melongena*, L. (Egg plant) Kodok.

Clypeolum sp. On *Amomum sp.* Yambio.

Kordyana celebensis, Gaum. On *Commelina benghalensis*, L. Yambio.

Periconia byssoides, Pers. ex Corda. On *Mucuna pruriens*, D.C. Yambio.

Phyllachora cynodontis, (Sacc.) Nicssl. On *Cynodon dactylon*, Pers. Bor and Yambio. Not hitherto recorded for Upper Nile and Equatoria Provinces.

Sporodesmium sp. (close to *S. bakcri*). On *Cajanus indicus*, Spreng. (Pigeon Pea). Kadugli.

SOOTY MOULDS.

Cladosporium sp. On leaves of *Medicago sativa*, L. (Lucerne). Bouga.

Cladosporium sp. with *Alternaria* sp. (*tenuis* group). On (1) leaves of *Cajanus indicus*, Spreng. (Pigeon Pea), Shendi (2) leaves of *Dolichos lablab*. Shendi.

Cladosporium herbarum, Link ex Fr. On (1) moribund petioles of *Carica papaya*, L. (Papaw). Wad Medani (2) dead twigs of *Hibiscus exculentus*, L. (Okra). Wad Medani (3) causing "blast" of Rice (*Oryza sativa*, L.) Meridi.

Meliola khayae, Hansford. On *Khaya senegalensis*, A. Juss. (Sudan Mahogany) Kagulu.

Pseudocampitum fasciculatum, (Cke. & Mass.) Mason. On branches of *Aleurites* sp. Yambio.

SMUTS.

➤ *Tilletia ayresii*, Berk. ex Massee. On *Panicum maximum*, Jacq. Yambio.

➤ *Tolyposporium ehrenbergii*, (Kuhn) Pat. On *Sorghum purpureo-sericeum* Aschers. & Schweinf. Jebel Moya.

✓ *Ustilago cynodontis* (P. Henn.) P. Henn. On *Cynodon dactylon*, Pers. Juba.

RUSTS.

Melampsora helioscopiae, (Pers.) Wint. On *Euphorbia geniculata*, Orteg. Yambio.

Puccinia hennopsiana, Doidge. On *Mariscus sieberianus*, Nees Yambio.

P. lippiivora, Syd. On *Lippia adoensis*, Hochst. Yambio.

P. romagnoliana, Maire and Sacc. On (1) *Cyperus difformis*, L Yambio. (2) *Cyperus digitatus*, Roxb. Yambio.

OTHERS.

➤ *Macrophomina phaseoli*, (Maubl.) Ashby. Storage rot of sweet potatoes (*Ipomoea batatas*, Lam.) Wad Medani.

✓ *Helminthosporium bicolor*, Mitra. Damping off of young wheat plants (*Triticum vulgare*, H.C.) Wad Medani.

Diplodia sp. (not *D. natalensis*) and occasional *Diatrypella* sp. On *Citrus* sp. twigs, apparently parasitic. Kadugli.

Phomopsis sp. On dead twigs of *Albizzia lebbek*, Benth. Wad Medani.

Papularia sphaerostroma, (Pers. ex Fr.) v. Hohn. On moribund *Sorghum* stalks. Yambio.

Hysterium sp. (marked *H. aff. pulicarc*, Fr.) On dead wood. Yambio.

Eutypella sp. On *Citrus* twigs. Kadugli.

➤ *Glomerella cingulata*, (Stoneman) Spaulding and Schrenk. On petioles of *Carica papaya*, L. (Papaw). Said to be associated with a fruit rot. Kadugli.

Hypoxylon haematostroma, Mont. On dead wood. Yambio.

Valsaria gemmata, (Berk and Rav.) Ellis and Everhart. On dead wood. Kadugli.

- Helicobasidium* sp. On base of trees and exposed roots of Teak (*Tectona grandis*, L.). Yambio. Apparently parasitic.
- Septobasidium* sp. On branches of Tung (*Aleurites* sp.) Yambio. Apparently parasitic.
- Fomes endotheius*, (Berk.) Cooke. On trunk of *Azadirachta indica*, A. Juss. (Neem). Wad Medani. Apparently parasitic.
- Hexagona discopoda*, Pat. and Har. On unidentified liana, apparently parasitic. Aza Forest.
- Haexagona dregeana*, Lev. On unidentified tree, probably parasitic. Dinder.
- Polystictus occidentalis*, (Kl.) Fr. On dead tree trunk. Yambio.
- ✓ *Trametes cingulata*, Berk. Associated with dry rot of building wood. Juba.
- T. corrugata*, Pers. On stump of Mango tree (*Mangifera indica* L.). Probably a wound parasite. Yambio.
- Lenzites palisoti*, Fr. On dead tree stump. Yambio.
- Irpex flavus*, Kl. On dead wood. Yambio.
- Battarreia stevenii*, (Lib.) Fr. On ground. Wad Medani.

COTTON BREEDING SECTION

The Gezira Station.

By R. R. Anson

METEOROLOGY.

Late rains followed by a long cold winter were the two most inclement and harmful features experienced during the season. The wet season ended during the second week in October. For details see report of Soil Research Section.

BREEDING AND VARIETY TESTING.

The breeding plot was sown at the normal time, (11.8.48) two days after rain, and given a light watering directly after sowing. Germination was good. Towards the end of the month (22.8.48) plants were dusted with benzene hexachloride against flea beetle. Termite damage was negligible. The following strains—DS₂, DS₃ and RDS were infected with blackarm (primary infection). Weather conditions favoured the disease and by 27.9.48 it had spread throughout the plot. Susceptible plants were severely attacked and shed lower leaves and first formed sympodia so extensively that one experiment, "Boll tagging at 14 day intervals for observation on grade", had to be abandoned.

The following material was planted and analysed:—

A. DOMAINS SAKEL.

- (1) J.R. 14/5=(J.R. 9/5 x D.S. 17)*—H₁ H₁ in rows and alternated with DS₁ (control). Samples have been forwarded to the Shirley Institute to ascertain whether the addition of H₁ is likely to affect lint quality.
- (2) Domains Sakel. Six plants selected for low Node Numbers (earliness) were propagated in progeny rows. Pure breeding re-selections will be carried forward.
- (3) BAR. 14/1 (Blackarm resistant Sakel carrying B₂) Nineteen selections made from a 300 plant random plot filter of this strain were grown in progeny rows and bulk analysed. Twelve of these will be carried forward to form new filtered material of BAR. 14/1.
- (4) BAR. 14/7. (Blackarm resistant Sakel B₂) occupied $\frac{1}{2}$ angia (41 rows of 25 plants). A few selections and 20 plant diagrams were made from material within it. However, new material BLR. 14/16, of similar composition, but carrying resistance to both leaf curl and blackarm will be available next season. Selection and filtering work on this new material will be given 1st priority.

* For explanation of symbols, See Appendix II.

B. X. 1730 TYPES.

- (1) BAR. 4/16 (Leaf curl and blackarm resistant strain carrying B₂ and B₃).

Eighteen outstanding selections from the analysis of 300 random plants grown at G.R.F. in the 47/48 season, were planted in progeny rows and bulk analysed. Six of these have passed the quality, regularity and improved yield tests and will be carried on to form a new filter of BAR. 4/16.

- (2) (BAR. 4/11 x X1730A) F₁ was backcrossed to X.1730 A and the product supplied to Shambat for out of season propagation in the winter of 1948/49.

- (3) BAR. XL (7th B/C B₂). Three selections from BAR. XL—44/48—46/48 were sown in the breeding plot as small bulks. Plant diagrams were made from these but no selection nor filtering work was done on them because it was decided to give full emphasis to work on the two fully resistant strains BAR. 4/11 and BAR. 4/16. This also applied to the BAR XL-1 bulks 47/48 and 48/48 and to the BAR. XL2 bulks 49/48 and 50/48.

- (4) J.R. 1530 (A hairy, high yielding strain showing some resistance to jassid). Fifty three progeny rows were analysed. The best six of these will be carried on for further analysis next season.

C. LEAF CURL RESISTANCE.

In the last E.C.G.C. Progress Report (1947/48) Evelyn describes an experiment designed by him to determine what degree of resistance was actually present in X.1730A and its BAR counterparts when exposed to conditions favouring the development of leaf curl symptoms.

It will be remembered that there was no leaf curl observed up to 31st March, 1948 and that further observations made after cutting back produced the following surprising results :—

Observation dates recorded fortnightly from 1st. October.	X 1730 A	BAR 1730L	BAR 4/5	BAR 4/11	BAR 4/16	Sig. Diff.	X 1730A Spreaders
% infection on 30.4.48	33.5	43.5	42.8	58.8	38.5	None	46.2
% infection on 19.6.48	56.0	64.0	54.8	62.5	49.5	"	58.0

It was thought that by eliminating all infected plants and bulking resistant ones, it might be possible to produce a strain very highly resistant to the disease. With this end in view, all plants showing any infection were up-rooted and remaining uninfected plants were again ratooned (20th. February, 1949) and subjected to infection.

Results were very satisfactory in that only two of the remaining plants, both from X.1730A, contracted the disease after the second cut back. These second ratoons were allowed to continue until 26th. March 1949, by which time sufficient quantities of self-bred seed had been collected from each strain. The number of resistant plants obtained was :—

BAR. 1730L—16 plants, BAR. 4/5—15 plants, BAR. 4/11—17 plants, BAR. 4/16—22 plants and X.1730A—20 plants.

Small bulk propagation areas for each of these strains will be grown in isolation next season.

Leaf curl resistant Domains Sakel and 1730 strains were grown in randomised blocks with 10 replications. Each plant of each strain was alternated with " Spreader " plants, as in previous years. The experiment was sown on 15.9.48.

Sakel Series.

Strains under test included :—

- (1) Free plants of R.D.S. 1-4 from L.C. Experiment 47/48.
- (2) Bulk of 1-4 from progeny rows 47/48 with lint length 39 mms.
- (3) Bulk of 1-4 from progeny rows 47/48 with lint length 36.6 mms.
- (4) Bulked self bred seed selected from Abdel Magid R.D.S., with good lint.
- (5) Bulked s.b. Domains Sakel Control of 47/48 lint length 36.2—38.8 mm.
- (6) R. 14/1—1/48 lint length 41—43.8 mm.
- (7) BAR. 14/7 (BAR. Dom. Sakel, B₂).
- (8) Commercial Domains Sakel Ex Gash.

The following table gives % leaf curl infection at 30.4.49, end of picking.

4	2	3	1	6	7	5	8
12.5%	12.5%	14.3%	20.0%	38.5%	88.0%	89.5%	94.0%
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% of leaf curl infection 15 days after cutting back.

2	4	3	1	6	7	8	5
23.0%	27.5%	28.8%	30.5%	43.0%	92.0%	94.0%	94.0%
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In Strains 1-4 leaf curl did not develop until late in the season. Varieties in brackets do not differ significantly at the 5 per cent level.

X.1730 Series.

Strains under test included :—

- 1 X.1730A Ex Gash.
- 2 BAR. XL. Ex Gash.
- 3 BAR. XL-1 Ex Hamid El Nil.
- 4 BAR. 4/5 Ex Gash.
- 5 BAR. 4/16 Ex Hamid El Nil.

% leaf curl infection when plants were cut back on 30.4.40.

5	2	3	4	1
2.0%	8.0%	8.5%	12.5%	14.5%

% leaf curl infection 15 days after cutting back.

5	2	3	1	4
6.0%	12.0%	17.5%	21.0%	25.5%

On neither date was there any significant difference.

D. COTTON VARIETAL TESTS.

Variety testing was carried out on the usual sites—Turabi in the north, Gezira Research Farm in the centre and Hag Abdulla in the southern portion of the Gezira. Sowing was completed on 14-15/8/48 and 13/8/48 and 11/8/48 respectively. For results see Appendix I.

At Turabi a slight outbreak of primary blackarm occurred but weather conditions were not conducive to spread; it therefore soon dried out and was not at any time severe. At the Gezira Research Farm however, weather conditions were most favourable for blackarm spread, so much so, that all sub-plots were heavily infected. Unfortunate as this may have been in one sense, in another it was most fortunate, because it provided the best test the resistant strains could have had and valuable information which might otherwise have taken years to obtain. It has been an object lesson which has given a clear cut example enabling an accurate assessment to be made of the relative values of varying degrees of blackarm resistance, in a bad blackarm year.

At Hag Abdulla the outbreak was considerable but much less severe. The three varietal tests have therefore provided evidence showing the relative values of blackarm resistant strains under mild (Turabi), considerable (Hag Abdulla) and very severe (G.R.F.) degrees of infection. The results, given in Appendix I, illustrate the value of blackarm resistance.

Spinning tests were carried out at the Shirley Institute for comparison of Evelyn's Selected Domains Sakel and the commercial bulk Domains Sakel. Results indicate a slight superiority of Evelyns but this is probably not significant.

E. GRADE EXPERIMENTS.

At the Gezira Research Farm, grade was so low throughout, that the many experiments designed to throw light on factors thought to influence it, gave very disappointing results.

1. *Sowing date and Spacing Observations, Plot 52.*

This plot contained two replications of 5 sowing dates and two spacings *viz.* 35 cm x 80 cm thinned to 3 plants per hole and 50 cm x 80 cm thinned to 1 p.p.h. The number of holes per ridge at 35 cm was 33, and at 50 cm, 22. Germination was excellent but grasshoppers did some damage to earliest sown cotton (23.6.48). Gaps thus caused were filled by transplanting seedlings at thinning time (30.6.48). No resowings were necessary on the later sowing dates. On 4.11.48 some severe cases of wilt were observed. These were mostly found on early sowing dates and there were more in the 50 cm spacing treatments than in the 35 cm spacing treatments. Infected plants shed all leaves and appeared dead but later recovered and put on new growth.

There was an indication that grade was higher in the earliest sowing, but it was low throughout. Yield was also highest in the earliest sowing, but replication was inadequate for any conclusion to be drawn.

2. *Wind Break Observation. Plot 27.*

There were 4 treatments. Each treatment occupied 1 acre (approx.).

- (1) Exposed to south wind.
- (2) Completely surrounded by 8 rows of dura.
- (3) Completely surrounded by 8 rows of ads (*Cajanus indicus*).
- (4) Exposed to north wind.

It was thought that the hot dry desiccating northerly winds which usually start at the end of October and continue throughout most of the picking period, might have an adverse effect on grade. For the first two pickings the sheltered treatments showed a slight advantage, but for the remaining 4 pickings there was little to choose between treatments. However, that which had been exposed to the north wind gave the worst grade throughout. Results might have been more conclusive had conditions been normal but premature boll opening, a condition which was general throughout the Gezira, probably masked any advantages.

3. *Type of Picking. Plot 242.*

There were two treatments:—

- (1) Picking every seven days.
- (2) Picking every fourteen days.

The grade for both treatments was exceptionally low and differences fell very short of significance.

4. *Sowing Date and Spacing. Plot 244.*

The experiment was set out in the form of a factorial 2×2 design.

There were 4 treatments :—

- (a) Close spaced early sown (35 cm x 80 cm. Sown 25th July).
- (b) Close spaced late sown (35 cm x 80 cm. Sown 15th. Aug.).
- (c) Wide spaced early sown (70 cm x 80 cm. Sown 25th. July).
- (d) Wide spaced late sown (70 cm x 80 cm. Sown 15th Aug.).

At the 5 per cent level early planting was significantly better than late planting but there was no significant difference between spacings.

Significant interaction indicated that early planting combined with wide spacing resulted in better grade.

5. *Good and Bad Seed. Plot 246.*

There were two treatments :—

- (a) Seed from Grade 1 cotton ex Gash.
- (b) Seed from Grade 4 cotton ex Gash.

There was no significant difference between treatments.

6. *Grade Trial Miscellaneous. Plot 246.*

Treatments.

- (a) Normal procedure.
- (b) Heavy sowing (40 seed per hole).
- (c) Heavy resowing.
- (d) Delayed thinning.

At the 5 per cent level there was no significant difference between treatments.

F. PESTS AND DISEASES.

White fly was worse than usual and may have accounted for *asal* spread. *Asal* was considerably worse than usual.

Thrips in contrast to last season, did very little damage.

Egyptian and pink bollworm. Neither E.B.W. nor P.B.W. appeared to be worse than usual although pink bollworm larvae seemed to be more in evidence on the seed cotton at ginning time.

Jassids were present but plants were not severely attacked.

Blackarm. Primary infection caused considerable damage to cotton at the Gezira Research Farm. This primary infection was traced to seed which had obviously been inadequately treated with

' Abavit B ' and had not been put through a delinting machine after ginning. Some seed had immature lint still adhering to it, which prevented the " Abavit B " dust penetrating to the seed coat. This severe outbreak of blackarm has caused a general tightening up of precautions. A delinting machine has been erected and next season a stronger concentration of Abavit B is to be used. Small bulks of seed to be grown in the Varietal Tests, Breeding Plots and Observation Plots are to be delinted with sulphuric acid before Abavit treatments.

Shambat Station

by

R. L. Knight

I. METEOROLOGY

The rains started in May and finished in October but the total rainfall for the year was only 2.8 inches—less than half the normal. Humidity was good however during the critical part of the season and blackarm inoculations ' took ' well.

The season was less hot than usual and there was a long cool winter. Unfortunately leaf curl was so severe in the in-season crop that the out-of-season season planting was delayed, with the result that the crop did not benefit to the full from the coolness. In the period 1st. May 1948, to 30th. April 1949, inclusive, there were 204 days when the shade temperature registered 100°F or over, 28 days with 110°F or more, and no days with a temperature of 115°F or over. These figures compare with 204, 34 and 3 days respectively, representing the average of the previous six seasons.

II. GENETICS AND BREEDING

A. BLACKARM RESISTANCE.

1. *Production of blackarm resistant " Egyptian Varieties ".*

(a) *Blackarm resistant Domains Sakel.* In last season's report it was stated that a 5-acre propagation area of Evelyn's Selected Domains Sakel, homozygous for B₂, was grown under the number BAR 14/7 in 1947-8 winter. Part of the seed from this plot was used for sowing 105 acres in the Gash this season and a small quantity was used for sowing in a replicated variety test at Medani where it yielded 476.8 lbs. lint per acre as against 387 lbs. from the parental Sakel control. This large difference in yield was due to severe blackarm attack in the early part of the season before the rains ceased.

It will be remembered that within this out-of-season 5 acre plot of BAR 14/7 two acres were selected as showing a high incidence of leaf curl. At the end of the crop these two acres were heavily rogued for

leaf curl, 17,310 diseased plants being pulled out and 3,847 healthy ones left. These leaf curl free plants were then cut back hard to induce secondary growth thereby making any latent leaf curl manifest itself. By 2nd October 1948 these 3,847 plants had been reduced by regular leaf curl roguing to 632 healthy plants but, of these, 390 had not at that date set a boll on their secondary growth. These plants were presumed to be lacking in vigour and, since vigour is desirable of itself and the lack of it tends to mask leaf curl, these 390 plants were pulled up. The remaining 242 plants were allowed to flower freely (being isolated) and were later bulk picked as the leaf curl resistant component of the blackarm resistant strain, BAR 14/7. The new strain was given the number BLR 14/16.

The seed of the 242 leaf curl free plants was used to sow a 1 acre propagation area of BLR 14/16 at Shambat in 1948 winter and this, at the end of crop, will be cut back and rogued for leaf curl again. A small quantity of seed was also sent to Medani for inclusion in a replicated leaf curl resistance trial, the results of which for the three varieties concerned are extracted below.

Variety							% leaf curl
Evelyn's Sakel	..	..	..	..	..	..	97
BAR 14/7	..	..	..	..	..	..	79
BLR 14/16	..	..	..	..	..	..	11

Further details of this system of breeding for leaf curl resistance, the system of grading used, and the genetic background of the work are given elsewhere (Hutchinson & Knight, 1950).

The synthesis of a Domains Sakel type of similar parentage to BAR 14/7, but carrying both B_2 and B_3 was held up by a severe attack of leaf curl. The B_2B_3 plants, though not producing enough seed for propagation, were utilized by crossing them with BLR 14/16 so as to combine leaf curl resistance with blackarm resistance. Two crosses with BLR 14/16 followed by roguing for leaf curl should be adequate for this purpose.

In the transference of the *arboreum* gene B_4 to Evelyn's Selected Sakel, homozygous B_4 plants of 10th. *barbadense* backcross composition (6th. backcross to Evelyn's Sakel) were raised and seed of these will sow a small propagation plot of the B_4 Sakel next season.

In a second transference from tetraploid *sanguineum* (*G. arboreum* race *bengalense*, Silow) to Sakel, 43 plants of second Sakel backcross type were raised and selections within these were again successfully crossed with Sakel. In this experiment the objectives are three-fold: (a) to find out whether a second transfer of B_4 by this technique will produce a B_4 Sakel with this gene at the same locus as in the material from the first transference, (b) to see if a strong intensifier of B_4 , thought to exist in *arboreum*, can be transferred, and (c) to transfer an *arboreum* hairiness gene to Sakel.

In the hybridization between tetraploid *herbaceum* (Wagad 8) and Sakel the second backcross to the latter, comprising 21 plants, was successfully raised, and selected plants in it were again crossed with

Sakel. Some of these plants showed marked blackarm resistance and some marked hairiness.

Hybridization involving the perennial *barbadense* type Grenadines White Pollen reached the third Sakel backcross stage and the resistance of this type has been shown to depend on a major gene, B_5 , fortified by minor genes. This work has been published in greater detail elsewhere (Knight, 1950).

(b) *Blackarm resistant Xi730*. Three blackarm resistant strains of Xi730 were on trial in the Gezira this season : BAR 1730L, BAR 4/5 and BAR 4/16. Full details of these trials will be found in the report for the Gezira Station. Twenty six comparisons of BAR 1730L, and twenty of BAR 4/5, with Xi730A, spread over a number of seasons, are now available and the averaged figures in pounds of lint per acre for these replicated trials are given below :

			BAR 1730L	BAR 4/5
Variety	..	..	537	470
Control (Xi730A)	..	..	537	505

Though BAR 4/5 is inferior in yielding power, BAR Xi730L is clearly the equal of Xi730A and its spinning tests over a number of years show it to be identical in lint quality also.

In my last season's Report (p. 3) the inferiority in the yielding power of BAR 4/5 and BAR 4/11 was attributed to the high proportion of Xi730H 'blood' in these two strains. To obviate this BAR 4/11 was crossed with Xi730A on a wide basis and the F_1 backcrossed to Xi730A. The F_1 of this backcross was grown in 1948-9 winter and F_2 seed has been produced for sowing next season. From this an Xi730A type homozygous for B_2 and B_3 will be bred.

2. Production of blackarm resistant strains of American Upland for the Southern Sudan and the examination of imported Upland types.

(a) *Blackarm resistant Uganda SP 84*: A propagation area of BAR. SP. 84 homozygous for B_2 and B_3 was grown this season and some 5,000 lbs. of pure seed was produced. This type is the BAR 7/8 mentioned in my last report.

(b) *Blackarm resistance of imported Uplands*. The degree of blackarm resistance shown by KP 28 from Uganda, and L.S.S. Victory, 216F, 199F, 244F, and 268F from India was given in my 1947-8 Report (p. 4). This season, F_2 s of hybrids of these types with Sakel and with B_2 Sakel were grown. Five F_2 progenies of each variety were raised in each of the above series but for brevity these have been shown below as totals. 216F was not included in these tests since it carried only about 20 per cent of resistant plants and these all showed typical B_2 resistance.

F_{2s} of imported Uplands x Sakel.

	Blackarm grade							
	'4'	'5'	'6'	'7'	'8'	'9'	'10'	'12'
Sakel controls	—	—	—	—	—	—	14	237
B ₂ Sakel Control	3	32	45	6	—	—	—	—
KP28 x Sakel	15	61	96	34	12	5	14	48
L.S.S. x Sakel....	45	232	166	46	21	8	26	86
Victory x Sakel	10	76	54	49	30	18	19	17
199F x Sakel	34	192	138	44	30	6	29	54
244F x Sakel	17	91	99	42	13	6	16	10
268F x Sakel	7	59	65	49	12	5	15	28

F_{2s} of imported Uplands x B₂B₂ Sakel

				Resistant	Susceptible
KP 28 x B ₂ B ₂ ..	..	..	..	99	—
L.S.S. x B ₂ B ₂ ..	..	..	..	536	—
Victory x B ₂ B ₂ ..	..	..	..	915	—
199F x B ₂ B ₂ ..	..	..	..	298	—
244F x B ₂ B ₂ ..	..	..	..	479	—
268F x B ₂ B ₂ ..	..	..	..	310	—

Clearly in each of these varieties B₂ is the major gene responsible for resistance, but minor genes fortifying the resistance conferred by B₂ are also present. These minor genes are responsible for filling the gap between grades '7' and '12' in the F_{2s} of these Upland x Sakel crosses.

3. Grading of American Cotton Belt Varieties.

Twenty fresh importations of commercial Upland varieties from the U.S. Cotton Belt were sprayed with inoculum and graded for resistance with the results tabulated below:—

Variety	Blackarm grade							
	'4'	'5'	'6'	'7'	'8'	'9'	'10'	
Control BAR.SP.84 B ₂	4	51	6	—	—	—	—	—
„ SUS.SP.84 b ₂	—	—	—	—	—	3	—	50
Acala 111 Rogers	—	—	—	—	—	4	—	10
Acala (Shafter P-18-C)	—	—	—	—	—	—	—	51
Rowden B.6	—	—	—	—	24	23	—	—
Rowden 42a	—	—	—	—	—	32	—	16
Rowden 2088	—	—	—	—	1	22	—	25
Mebane (Triumph)	—	—	—	—	—	3	—	17
Mebane	—	—	—	—	—	7	—	6
Nucala	—	—	—	—	—	—	—	47
Oklahoma Triumph '44'	—	—	—	—	1	8	—	34
Rhynes Cook	—	—	—	—	1	16	—	30
Clelewilt '7'	—	—	—	—	—	1	—	18
Coker '100' No. 6	—	—	—	—	—	1	—	22
Delfos 9252	—	—	—	—	—	—	—	1
Deltapine 14	—	—	—	—	17	8	—	—
Express 6637	—	—	—	—	—	6	—	22
Express 11384	—	—	—	—	—	11	—	35
Stoneville 2B 8275	—	—	—	—	2	15	—	7
Stoneville 2C 7303	—	—	—	—	—	31	—	23
Wilds 16.Sc.	—	—	—	—	—	6	—	46
Young's Acala....	—	—	—	—	—	3	—	45

(C) VARIOUS.

1. *Jassid Resistance.*

The economic and genetic background of this line of research was given in my last season's Report (p. 6). This season the work suffered by reason of a severe leaf curl attack on the 1947-8 and 1948-9 crops and many progenies failed to produce seed. Nevertheless, the full hairiness of MU8b was recovered in the F_2 of the second Sakel backcross, and third backcross progenies were raised in 1948-9 winter and selfed. Work with Ferguson has also continued on similar lines but in all these transferences the hairiest plants in the early backcrosses suffer from marked sterility. Both in the MU8b and Ferguson lines, however, there is evidence that this is breaking down in the third backcross material now growing out of season.

The basic hairiness gene from MU8b was carried to the 6th Sakel backcross (the last two crosses having been to BAR 14/7) and this material was crossed with BLR 14/16 in 1948-9 winter to add leaf curl resistance. A similar course was adopted with the main H gene from Kapas Purao, *G. punctatum*, St. Ignatius, *G. tomentosum*, and *G. mustelinum*.

The success of this work will depend ultimately on lint tests. There can be no doubt that the full hairiness of several of these *hirsutum* types can be transferred to Sakel but none of the transferences has yet gone far enough to allow of lint tests being carried out. The first lint tests are, however, available on JR 14/5 (Evelyn's Domains Sakel to which H_1 has been transferred from Tanguis) together with its parental Sakel control:

	Effective length.	Hairwt.	Standard Count x strength			H.S.C.
			80's	100's	120's	
JR 14/5	49	135	2708	2568	2209	120
Evelyn's Sakel	50	127	2779	2515	2302	123

These figures suggest that H_1 can be transferred to Sakel without upsetting lint quality. Since the Tanguis gene H_1 also appears to be the basic gene governing hairiness in MU8b and St. Ignatius, it is to be hoped that part, if not all, of the excellent hairiness of these types can be transferred to Sakel without affecting lint quality.

2. *Deciduous Bractlet*

The transference of the gene controlling this character, to Sakel and BAR. SP. 84 will be discontinued, since this season's families have shown that the character can not be freed from its subsidiary deleterious effects on boll size, boll shedding, leaf abnormality and reduced fertility. These secondary effects of the gene are easily negated by selection, presumably as a result of minor gene modification, but such modification also reduces the main expression of the gene so that the nearer the

plant is brought to normality the less the effect of the gene on the bracts. In fact, a fully normal plant can only be produced at the expense of so modifying the expression of the main gene that the bracts cease to be deciduous.

3. Cluster Characters.

The transference of "Egyptian short-branch" and of *hirsutum* "Cluster" to Sakel will also be discontinued as a result of this season's work. When fully transferred, these genes were found to have such a weak expression as to be of no economic significance.

4. Transference of Lint Strength from *G. Thurberi* to Sakel.

Three families were raised this season as a result of hybridization between the three strongest plants in last season's plot and BAR 14/7. The composition of these families was (*G. "thurbadense"* x Domains Sakel³) x BAR 14/7 F₁. All suffered a crippling attack of leaf curl but a small quantity of self-bred seed was obtained from most of the plants and several were selected which appeared to carry the *thurberi* strength. The best of these plants have been crossed with BLR 14/16 to introduce leaf curl resistance, and their lint is being sent to the Shirley Institute for test.

As pointed out in my last season's report this work has two possible uses. Firstly it offers a means of increasing the strength of Sakel by some 22 or 23 per cent. Secondly, in jassid resistance breeding, should the addition of leaf hairs increase the fibre hair-weight, this material with standard hair-weights of 104—107 would be useful for again reducing it.

5. Wild *Gossypium* accessions.

Seed of *G. anomalum* was sent in from Semeiha on the Abu Habi Scheme in Kordofan Province, where it was growing on goz land near to the cultivated cotton area. Another accession was received from Gibril (12°50'N, 28°13'E), 17 miles NW of Nahud, where it was found on the flat plain of a small khor.

DISEASES AND PESTS

Blackarm (*Xanthomonas malvacearum*) was, as usual, general during the rains.

Leaf curl was again exceptionally severe, more so even than last season.

The control of pink and Egyptian bollworm by spraying with Gammexane and D.D.T. seemed ineffective this season. Towards the end of the season an arsenical spray was substituted and appeared to reduce the amount of damage.

Kadugli Station

(KAMINA EXPERIMENTAL FARM)

by

M. F. Rose

METEOROLOGY

From the point of view of field experimentation the season was bad, probably the worst on record ; this can be ascribed directly to an exceptionally low rainfall, badly distributed.

Rains broke normally in mid April but by the end of June only 137 mm. were recorded, less than half that recorded for the same period in the 1947 season. Where abundant seed of miscellaneous crops was available, advantage was taken of fair planting conditions in mid June but it soon became apparent that all such plantings would have to be resown owing to the lack of following rains. Drought conditions were broken, however, on July 2nd by a precipitation of 62 mm, the first good rain of the season. It was imagined that the true *kharif* had commenced and all breeding material (cotton and dura) and main experiments were sown on this rain. Drought conditions followed and from the middle of July it was necessary to save the cotton breeding plot by hand watering. From July 15th to August 30th, 8 tons of water were carted and applied to the single plants on every third day, no small strain on the resources of the staff with its fluctuating supply of casual labour. Such conditions persisted until the end of August when a timely 42 mm saved the situation. Thus the crop was allowed neither to establish itself nor develop.

September rains were good and above average but these had little effect on plants already stunted and desiccated by two months' drought. In the middle of October the crop showed marked drought effect (owing to lack of reserve moisture in the soil) and by the end of the month most of the top crop had been shed. There was much premature opening and both the quality and quantity of the crop was well below average. Bulk G.O.T.s were, on the average, down 2.5 per cent.

Relevant data for Kadugli and the Jebels area are presented in Tables I and IA. It will be noted that the seasonal rainfall for Kadugli was 215 mm below average and only 31 mm above the record low of 508 mm in 1937.

TABLE I.
Rainfall mm.

	Feb.	Mar.	April	May	June	July	Aug	Sept.	Oct.	Nov.	Total
Kadugli 1910-1947	2	1	15	79	124	152	156	137	82	6	754
Kadugli 1948			9	40	85	114	87	174	30	—	539
Dilling			1	97	110	177	134	108	7	—	634
Lagowa				133	53	40	159	75	9	—	469
Talodi			38	23	155	117	103	244	86	3	769
Kologi			42	110	210	153	129	174	34	5	857
Abu Gebeiba				37	71	96	100	135	15	7	461
Um Berem-beita				75	47	288	233	89	8	—	680

TABLE IA.
Temperature °F.
Kadugli 1947 and 1948.

	Mean Max.	Range	Mean Min.	Range
Period Resting. Dec. —May 47	99	108-69	67	82-56
„ „ „ „ 48	97	109-76	66	82-53
Period Growth June—Nov. 47	92	102-75	68	77-56
„ „ „ „ 48	90	103-73	67	76-56

COTTON

A. COMMERCIAL CROP.

With a guaranteed minimum price of 22/- per 100 lbs. for grade I seed cotton, the demand for seed was great. BAR. SP. 84 seed (ex Kologi) was distributed to the whole of the Eastern and Western Jebels (15,644 kantars) with the exception of Lagowa which received strains NT. 96/40, NT. 58/43 and NT. 205/43 (2,600 kantars). Owing to the shortage of BAR. SP. 84 seed in the general change-over from Pump Scheme Strain, Lagowa could not be served, but this will be remedied in the 1949-50 season when the whole of the Nuba Mountains will be under BAR. SP. 84.

Much abandoned land was brought under cultivation and, in many cases where labour was scarce, cotton was grown at the expense of the dura acreage. Estimated areas and returns are given in Table II but yields must be regarded as peculiar to the present season with its extremely local and erratic rainfall. Thus Um Berembeita had only 300 mm of rain on the growing crop while Lagowa, with 24 rainless days in July, could boast of only 40 mm in that important month.

TABLE II.

	Estimated Area (Feddans)	Yields (small kantars of 100 lbs)	Total
Dilling	9,000	13,760	201,570
Kadugli	15,700	76,720	
Lagowa	8,000	25,800	
Talodi	11,400	35,320	
Kologi	7,000	23,630	
Abu Gebeiha ..	7,600	17,230	
Umm Berembeita ..	7,000	9,110	

Mean = 3.1 small kantars per feddan.

B. BREEDING WORK.

The breeding plot, planted on July 2nd, comprised the following five distinct groups:—

- (1) BAR. SP. 84. 105 progeny rows for 'type improvement' and 15 for 'type maintenance'.
- (2) Nyasaland types. 9 progeny rows from L-C 20-4 and 7 from MZ 561.
- (3) Wilds 11. 23 progeny rows.
- (4) U4/8161 x MU8. special bulks A332, A449 and A455.*
- (5) U4/5143 x Cambodia. special bulks A2106 A220 and A292.*

Excellent stands were obtained in all groups but it soon became apparent that previous drought conditions and the lack of an adequate moisture reserve would adversely affect plant development. On August 22nd, at the commencement of flowering, average plant height was 35 cm only: profile pits dug over the area indicated that the rains had penetrated to a depth of 18 cms and that there had been no effective link-up with sub-soil moisture. Selfing commenced on August 28th and in order to save as much seed as possible any plant which looked like surviving and giving some return was taken: rain on August 31st saved the situation and allowed single plant selection to be made. Final returns of seed cotton per plant were very low but sufficient to allow of the routine laboratory analyses.

Group 1.

For earliness and all round performance BAR SP. 84 derivatives showed up well. Types far superior to the commercial bulk have been sorted out and these will be tested in small scale trials in the near future. One feature only in the make-up of the commercial crop is open to criticism, its maturity is down compared with that of its predecessor, Pump Scheme, when grown under very poor conditions. There is every indication, however, that this defect can be remedied by selection, and in this respect data from spinning tests will be of major interest and importance. Data from the four most promising lines 266, 301, 714 and 723 are given below: their strength and yarn appearance in relation to that of the parental bulk is worthy of note.

TABLE III.

		Lea product (40s)	Yarn Appearance	
266	} ex BAR. SP. 84 ..	2,456	Mod.	small scale
301		2,503	F.G.	S.T. Report
714		2,427	G.	159. 1947/48
723		2,461	G.	
Parental BAR. SP. 84	..	2,324	F.G.	
P.S.S.	.. ..	2,194	F.G.	

* The six special bulks kindly supplied by C. E. S. Barberton Transvaal

Group 2.

Under the conditions of a normal season in which heavy rain is concentrated in the months of July and August, Nyasaland selections have tended to become coarse and woody with profuse vegetative growth. For this reason work since 1945 has been directed in selecting more open, less lush types, at the same time retaining the prolific fruiting capacity, hairiness and lint quality (strength) of the original introductions. The present abnormal season, however, put the necessary check on such development and induced a more normal plant structure : by the end of August, this group stood out as the most robust in the breeding plot, and although showing drought effect, came through to give individual plant yields of a high order. There is some resemblance between the present Kadugli season (1948) and the normal season in the eastern rainlands (Gedaref area) and it is worth speculating on the behaviour of such types under such chancy conditions.

From general observations and node counts over the whole group it is apparent that MZ 561 derivatives are earlier than those from CL 20-4 : for this season more attention will be paid to the former sub-group.

Group 3.

The Zeidab quality types, selected primarily for earliness in 1947 from Wilds 11 (the commercial N type of the Sudan), did not seem unduly affected by the change of conditions from an irrigated to a dry-land crop. Considering the drought, initial growth was fair but it soon became apparent that jassids were having a retarding influence on subsequent plant development. This continued until harvest time when all lots showed typical leaf scorch : final yields were markedly reduced by jassid damage, a fact directly related to the glabrousness of the plant : plant appearance from mid-season onwards was a sharp reminder of the presence of jassids in the Nuba Mountains area and of the necessity to maintain the requisite standard of hairiness (both length and density) in the commercial crop.

From the 23 lots on hand an attempt will be made to select and fix early-maturing types. Under Zeidab conditions pink bollworm and the capsid bug *Creontiades* take a fair toll from the early mid-season crop : with an earlier maturing type such loss and damage might well be shifted to the later pickings with a consequent increase in final yield and improvement in overall grade. If earlier types be evolved, lint quality will have to be re-examined under the normal Zeidab conditions of irrigation.

Groups 4 and 5.

The two groups are contrasted in Table IV and the following generalizations can be made from field observations. Under the abnormal conditions of season the three Cambodia types A2106, A220 and A292 were definitely more sturdy and robust than their MU8 counterparts : they were later and carried a heavier crop with A220 heading the yield figures in seed cotton. Opening in all six lots was good and clean with the MU8 derivatives yielding a higher percentage of their total crop in the earlier pickings : the group as a whole was stronger and more

vigorous than the BAR SP. 84 selections but less so than the Nyasaland lots (Group 2).

Attention will be centred on the MU8 derivatives not only because of their relative earliness but because of their high maturity ratios (especially A455) under Barberton conditions. It remains to be seen whether this standard be maintained under the short growing season (5 months) of the Kadugli area. It must be pointed out, however, that none of these types can approach the re-selected BAR. SP. 84 material in earliness.

TABLE IV.

Strain	Mean Blackarm Grade	Mean Node No.	G.O.T. * Powersaw	Lint Index gms.	Seed Wt. gms.	Mean Max Length (mm)	Yield per acre. S/C lbs.
A2106	6.7	8.0	31.0	6.5	12.0	35.4	1517
A 220	6.2	7.8	30.3	6.9	13.4	36.6	1601
A 292	6.3	7.9	31.7	6.1	12.0	35.7	1247
A 332	6.5	7.5	32.0	7.1	13.5	36.2	1544
A 449	6.0	7.6	31.6	7.5	14.1	36.3	1163
A 455	5.4	7.2	32.7	6.3	12.0	36.0	1095

* All G.O.Ts down 2.5 percent on average.

C. EXPERIMENTAL.

3⁴ Factor Experiment.

This experiment of 81 plots (9 blocks x 9 treatments) follows directly from the spacing experiments initiated in 1946. Fortunately the trial was sited on the most low-lying block on the Kamina Farm, otherwise it would have shared the same fate as that of subsidiary experiments.

The treatments were :—

- (1) Three levels of increasing earliness : V₀ = Pump Scheme strain, V₁ = BAR. NT. 96/40, V₂ = BAR SP. 84.
- (2) Three planting dates : D₀ = 2nd July, D₁ = 27th July, D₂ = 4th August.
- (3) Three intra-row spacings : S₀ = 45 cms, S₁ = 60 and S₂ = 90 cms.
- (4) Three levels of plants per hill at final thinning ; H₀ = 2, H₁ = 3, H₂ = 4.

The inter-row spacing was constant at 90 cms. Each level of planting date was thinned on two occasions, the first at the 2nd rough-leaf stage, the second at the 5th rough-leaf stage : these thinnings were approximately 15 and 25 days respectively from planting date.

Pickings per sub-plot (0.02 acres) were bulked and whole plots were ginned. Yields of lint per acre (to the nearest pound) for the 12 treatments are shown in Table V. Table VI gives main effect and interaction values.

TABLE V.

Lint per acre (lbs.).

Treatment							Yield
V ₀ .	(P.S.S.)	..	..	..	..	..	259
V ₁ .	(96/40)	..	..	..	..	..	268
V ₂ .	(84)	..	..	..	..	..	259
D ₀ .	(2/7)	..	..	..	..	..	417
D ₁ .	(27/7)	..	..	..	..	..	220
D ₂ .	(4/8)	..	..	..	..	..	149
S ₀ .	(45)	..	..	..	..	..	286
S ₁ .	(60)	..	..	..	..	..	270
S ₂ .	(90)	..	..	..	..	..	232
H ₀ .	(2)	..	..	..	..	..	248
H ₁ .	(3)	..	..	..	..	..	270
H ₂ .	(4)	..	..	..	..	..	269

Overall G.O.T. BAR. SP. 84 = 31.2 per cent : BAR. NT. 96/40 = 30.4 per cent : P.S.S. = 28.4 per cent.

TABLE VI.

Main Effects and Interactions. Lint per acre (lbs.).

Factor				Linear Response	Curvature	Factors	Interaction
V	..	..	..	— 0.07	— 17.0	V D	— 9.7
D	..	..	..	— 268.1*	+ 125.3*	V S	— 5.5
S	..	..	..	— 53.7*	— 22.0	D H	— 24.1
H	..	..	..	+ 20.4	— 22.85	S H	+ 14.2
Standard Error				+ 12.04	+ 20.8	V H	+ 27.0
				S*	S*	D S	— 5.1
						Standard Error	+ 14.7

Date of Planting.

It is apparent from Table VI that, under the conditions of the experiment, date of planting has had a greater affect on final yield than has spacing, spacing than plants per hill and plants per hill than variety. The curvature for D is significant at the 1 per cent level. Such data fully confirm the statement in the Kadugli Report Season 1946/47 that "time of planting is more important than strain under Nuba Mountains conditions".

It can be definitely stated that in the Kadugli area, given suitable planting conditions, the best and safest time for planting is early July : from mid-July onward yields fall off rapidly as instanced by the very low yields of D1 and D2.

Cotton statistics for the years 1935-9 show the Nuba Mountains crop to average but 1 kantar (315 lbs) of seed cotton per acre. Such very poor yields may well be determined by late planting which in itself is intimately connected with the practice of mid-season and late *harig*. Good vigorous crops can be grown on early *harig* which would indicate that *harig* cultivation *per se* is not directly responsible for the marked lowering of yields. The leaching of available nitrogen from the soil by the early rains might well condition the poor development of a late planted crop.

Spacing.

For the 3rd consecutive season the 45 cms spacing (286 lbs lint p.a.) showed a significant increase over the 90 cms (232 lbs lint p.a.). The seasons in question offer a fair sample of the fluctuating conditions in the area and the effect of season on spacing is shown below :—

Season				Type of Season	Lint 45/lint 90 cms.
1946	..	..	..	V. Good	1.43
1947	..	..	..	F. Good	1.18
1948	..	..	..	Bad	1.23

It will be noted that the 45 cms spacing has given consistently higher yields despite the type of season. Complete spinning test data from spacing experiments to cover 4 years will be available at the end of the 1949 season : todate there is no evidence that the closer spacing has had a harmful effect on yarn strength or appearance.

Interactions.

Although no interaction is statistically significant at the 5 per cent. level, certain trends are shown by the high values of DH and VH. Two 3 x 3 tables are presented and their practical implications are discussed.

TABLE VII.
Lint per acre (lbs.).

	Do	D1	D2	M		Vo	V1	V2	M
Ho	380.2	213.0	151.4	248.2	Ho	254.2	262.4	228.2	248.2
H1	444.2	220.0	145.4	269.8	H1	265.4	281.0	263.4	269.8
H2	427.2	228.4	150.4	268.7	H2	258.8	260.4	286.6	268.7
M	417.2	220.4	149.1	786.7	M	259.5	267.9	259.3	786.7

$$DH = \frac{1}{2} (D_2 - D_0)(H_2 - H_0) = -24.0 \quad VH = \frac{1}{2} (V_2 - V_0)(H_2 - H_0) = +27.0$$

On poor land and in late plantings it is customary for the cultivator at thinning time to leave a larger number of plants per hole: the D.H. table would indicate that whereas some benefit may accrue from such a practice in early plantings, no such advantage can be expected in the late plantings.

Plant habit and growth is responsible for the large V.H. value; BAR. SP. 84 with its neat compact habit can tolerate a higher plant population per hill than the coarser, strong-wooded types P.S.S. and BAR. NT. 96/40. With the acceptance of BAR. SP. 84 as the commercial crop in the Nuba area this point should be borne in mind.

The low value for V.D. is also of practical significance. It runs counter to the belief that the ill effect of late planting can be offset by planting an early variety. Early maturing types are required for the Nuba area but for a successful commercial crop these must be planted early.

In review, the experiment brings out the importance of good cultural practice: the figures indicate that BAR. SP. 84, early planted, close spaced, at three plants per hill (V₂, D₀, S₀, H₁) will yield 431 lbs lint per acre: the same variety late planted, widely spaced, at 2 plants per hill (V₂, D₂, S₂, H₀) will return only 108 lbs. This is a four-fold increase as a result of intelligent husbandry.

D. PESTS AND DISEASES.

1. *Pests.*

Possibly due to the extreme droughty conditions, the season was remarkably free from pests and diseases. The leaf roller, *Sylepta derogata*, was the only pest which reached epidemic proportions. It appeared on 22nd August, three weeks earlier than usual, and continued in the crop until the end of October: very bad damage was witnessed in outside areas but on the Kamina Farm the pest was controlled by hand-stripping of affected leaves.

From the 'squaring' of cotton, bollworms made their appearance in the sequence American, Egyptian, Sudan and pink. Visual assessment would place the damage as slight and below average.

Regarding stainers, the first migrants of *Dysdercus supersticiosus* were found in cotton on the Kamina Farm on October 2nd: owing to the regular hand collection of the bugs, it was impossible to judge the rate of breeding and the possible potential population. Observations on western outlying areas, however, would indicate that the initial influx and peak populations were well below average, with *supersticiosus* outnumbering *fasciatus*: in the Eastern Jebels this order of dominance was reversed. The local crop was one of the cleanest on record, with true staining negligible.

2. *Diseases.*

Blackarm (*Xanthomonas malvacearum*) was the only disease of note, with an effect most marked on the late plantings of the susceptible Pump Scheme Strain.

Blackarm counts over the whole of the breeding plot on August 11th and 12th indicated an infection (light) of only 3 per cent : Pump Scheme, planted out in separate control plots throughout this area, showed no infection at all. Following the good September rains the situation changed and blackarm soon made its appearance in both resistant and susceptible material. Counts on September 29th made in early August plantings (Expt) showed 10 per cent infection of both P.S.S. and BAR. SP. 84 : whereas the former returned a mean blackarm grade of 8.7 with marked stem lesions, the latter demonstrated its resistance with a mean grade of 6.9. Early planted (July 2nd) BAR. SP. 84, counted on the same date, returned the low mean grade of 3.7.

The value of the resistant gene B_2 in the commercial crop has been amply demonstrated during the present season.

DURA

A. BREEDING.

On July 2nd. four early, twelve mid-season and five late types were planted out in progeny rows. In spite of bad conditions, emergence was fairly good and later on in the season it was possible to discard by progeny rows. Final yields per head were low with seed weights well below average.

The 'head-to-row' method has now become routine practice in an endeavour to maintain the identity of good high yielding types in the welter of material available in the Nuba Mountains.

B. PROPAGATION.

Small special bulks of Fanda, Tahas 85, Toto, Karinaka and Birgalli Ahmer (2/3 acres each) were maintained for local seed distribution. The final mean yield of 635 lbs per acre was half that of a normal season.

LUBIA HELU (VIGNA SINENSIS)

The abnormally dry season did not assist in the final selection of types resistant to the mosaic disease so commonly found under the local conditions of concentrated rainfall : the susceptible local type (grown as a control) showed little infection and white fly (the suspected vector) appeared in the crop as late as September. Under such conditions it was impossible to whittle down still further the 8 resistant types and these will be carried forward to next season. Kadugli 12, the last early type remaining from the 1947 season, shared the same fate as its predecessors for it was killed off by Mylabrid beetles (flower stage) and by *Anoplocnemis curvipes* (pod stage). Two years' experience with early types would indicate that they cannot survive the early swarming of these two pests.

GROUNDNUTS

Four propagation plots of Barberton, Medani Erect, American Erect and Abu Arbaa were planted on July 15th. All lots established themselves well under difficult conditions but following the dry October, many plants died through lack of reserve moisture in the soil and stands became very patchy. Final yields were down to a mean figure of 467 lbs undecorticated nuts per acre.

Oil analysis figures from the 6 types grown in the 1947-48 variety trial are now to hand and are given to complete the picture : Barberton 46.38 per cent, Medani Runner 44.81 per cent, Medani Erect 46.53 per cent, American Erect 47.96 per cent, Kadugli Runner 46.33 per cent, Abu Arbaa 42.28 per cent.

SESAME

The importance of sesame as an oil crop and one which fits in well with late planting under *harig* conditions has led to the development here of early maturing strains, resistant to the so-called *marad el dam* disease (*Bacterium sesami*). On the lighter clay loams, groundnuts find a place in the cotton-dura-groundnut rotation but on the black heavy clays, harvesting conditions preclude their use : on this soil type sesame can be grown to advantage and is an admirable crop for late planting.

The types of sesame grown during the present season were (i) Susceptible Red (ii) Early Resistant White (iii) Resistant White Bulk. The Early Resistant White (ii) was derived from the bulked product of the 98 early single plants selected from (iii) at the end of 1947 season. On July 6th this small special bulk was planted out in single rows alternating with two rows of the Susceptible Red. On September 2nd, *marad el dam* appeared in the 'red' rows and in three weeks every plant was carrying the disease : the rows of Early Resistant White showed marked resistance : these were heavily rogued and any doubtful plant removed. From this material 11 single plants—early (93 days), prolific and with steep flowering curves—were selected. These will be planted out as single plants in the 1949-50 season.

The possibility of avoiding the disease by a change of planting date was considered and, using the Susceptible Red, an experiment was laid down with three planting dates, July 6th, July 17th and August 4th, replicated five times. All plantings succumbed to the disease with a complete crop failure over the experimental area. Self-sown sesame on field headlands, germinated by early June rains, also showed symptoms of the disease so it would appear that a change of planting date as an avoidance policy would be to no purpose.

The appearance of this disease in a susceptible crop does not mean a reduction in yield : it means a complete crop failure. Resistant White types developed here will give fair yields under the worst conditions of infection (vide 1947-8 Report) and in doubtful areas the cultivator should be warned against the use of the Susceptible Red : a limited amount of the resistant white seed is available for local distribution.

Plant Propagation

by

C. G. Webster

FOOD CROPS

Dura.

The propagation of the varieties Dwarf White Milo, Feterita Maatuk, Feterita Wad Hussein, Wad Fahl, Feterita Dwarf Managil and Dwarf Gassabi was satisfactory with yields sufficient for the estimated requirements.

On smaller areas 6 varieties were propagated for observation and seed increase—observations were recorded as follows :—

Abu Sabein	..	Early maturing variety of relatively pure stock.
Aklamoi White	..	Colour impurities practically eradicated.
D. Yellow Milo	..	Similar in habit to D. White Milo—yielded well from the purposely late sowing.
Hemeisi and Safra		Very susceptible to midge attack.
Abu Kudur	..	Fungus on heads during milky stage.

Combine varieties, including 2 new introductions from the U.S.A., Bonita and Caprock, were also grown for seed maintenance. Bonita is a Hegari type, unawned, dwarf and early maturing. It tillers heavily and yielded at the rate of 2400 rotls per feddan. Caprock is an awned mixture of dwarf and double dwarf types.

Maize.

Three varieties ECR/321 Mexican June, ECR/320 Peruvian Yellow and ECR/492 Hickory King were sown for seed multiplication. Exceptionally poor growth and fertilization was recorded against ECR/320 and ECR/492.

The propagation of ECR/490 Shendi Beladi and ECR/738 Peruvian Yellow hybrid was a complete failure.

Of the 53 new trials and introductions 15 varieties will be given further trial, ECR/740, 741, 744, 746, 900, 901, 920, 921, 1014 to 1020.

Dukhn.

Roguing continued on the black and yellow awned selections of the Kordofan variety ECR/205.

From the 19 varieties sown for observation, 2 were chosen as the most promising, an awned type from Nigeria ECR/344 Migashi, and a local variety from Fung ECR/919.

Wheat.

Forty varieties, introductions from Australia, U.S.A., Mexico, Egypt and Russia, were under observation. Growth overall was poor to fair with many of the varieties very late maturing.

Varieties considered promising and selected for further trial were ECR/795, ECR/796 Australia, ECR/729, ECR/730 Mexico and ECR/554, ECR/555 Egypt.

No off-types were observed in the 1 feddan propagation of the Indian wheat ECR/1060. The red and white seeded selections ECR/1062 and ECR/1063 of the Beladi variety reproduced true to type.

Barley.

Five varieties were sown and two go forward for seed increase, ECR/47 Beladi and ECR/556 Egyptian 16.

OIL CROPS

Sunflower.

Seven varieties were sown for seed increase and although growth was fairly good the yields were on the whole poor. Further use will be made of the best yielding varieties ECR/314, 542, 616, 618.

The most promising of the 53 new trials and introductions go forward for observation next season ECR/558, 617, 623, 760, 827, 834, 841, 842, 843, 845, 847, 852, 853, 854.

Groundnuts.

From the 40 new introductions, 15 varieties showing promise as regards growth and yield, were selected ECR/661, 662, 667 to 671, 673, 677, 893, 931, 1101 to 1104.

Last seasons selections, 13 varieties, were also on trial. Nine varieties were discarded, leaving ECR/419 Beladi Bunch, ECR/420 Barberton, ECR/424 Zande and ECR/583 Ashford.

Soya Bean (Summer).

With the exception of ECR/759, last year's selections were of the shattering type. All varieties were late maturing and ripened unevenly. ECR/759 Kadugli Yellow will be given further trial.

Of the 23 varieties under observation for the first time eight were chosen for trial 1949/50 :—ECR/973, 974, 993, 994, 998, 999, 1001, 1002.

Soya Bean (Winter).

Seed of 13 varieties was dressed with the inoculant 'Nitragin and a few rows of each variety sown on 21 November. In comparison with the August sowings, without inoculants, the growth and plant development was poor. The healthiest and most vigorous varieties were ECR/759 Kadugli Yellow, ECR/973 Belgian Green ECR/974 Belgian Yellow and ECR/1001 American C.N.S.

Safflower.

Five varieties were grown for seed increase : ECR/601, 772 from local sources and ECR/864*, 865, 866 introductions from America.

Sesame.

The Gedaref selection ECR/991 Hiraher Khafeef was the best of the varieties brought forward from last season.

An introduction from the U.S.A. ECR/972, a non-shattering type, showed promise of adaptation.

Introductions from Egypt and new trials of local varieties were complete failures under Gezira conditions.

PULSE CROPS.

Cowpea.

The table cowpea ECR/860 Ala Brown Eye, an introduction from the U.S.A., was the outstanding variety propagated as regards earliness, vegetative growth and yield.

The varieties ECR/939, 940, 977, 978, White, ECR/942 Brown and ECR/513 to 516, 518 Kadugli Cowpeas were considered the most promising of the observation trials. Twelve varieties of mixed stock were discarded.

Five varieties were sown for seed increase ECR/77 Iron, ECR/78 Brabham Mottled, ECR/79 Brabham Buff, ECR/169 Tanganyika and ECR/209 Gerbeara.

Beans.

From the 11 varieties sown for observation 6 were selected for seed increase 1949/50—ECR/67 Cluster Bean, ECR/756 Congo Bean, ECR/757 Sword Bean, ECR/769 Tepary Bean, ECR/770 Jack Bean and ECR/857 Velvet Bean.

Gram.

The green gram ECR/65 was successfully grown for seed increase and a failure recorded in the trial of the black gram ECR/63 Hyderabad.

MISCELLANEOUS CROPS

The Indian lubias ECR/127 and ECR/135 yielded at the rate of 400 and 600 rotls of seed per feddan respectively.

Selection of Deccan hemp was continued on the two varieties propagated ECR/985 Cut Leaved and ECR/986 Whole Leaved.

Eight varieties of potatoes, four from Scotland and four from the U.S.A. were sown on the riverain soil of a private pump scheme. The U.S.A. varieties ECR/915, 916, 917, 918, grew well producing good sized tubers.

Five American varieties of sweet potato were grown and the produce distributed to the Research Division Staff who commented favourably on the variety ECR/883 Porto Rico. Vine cuttings were distributed for trial against the Beladi varieties.

Twenty six propagations were carried out with little or no success.

Okra (bamia) ECR/967, 968, 969, Ocimum ECR/979, 980 and Cape Gooseberry ECR/1010 go forward for seed multiplication.

Russian Dandelion failed to germinate.

The Babun* varieties ex Fung were a mixture of runner and erect types. Green gram off types were evident and with the roots failing to develop the varieties were considered undesirable.

The propagations of Abyssinian Beans, Abyssinian Peas, Abyssinian lubia, Kodo and Kamoun were complete failures.

Madagascar groundnuts ECR/932 did not do well and the balance of the seed will be sent to rainland areas for final trial.

The Telebun (*Eleusine*) variety and the seven varieties of South African grasses were considered unsuitable. The balance of the seed was sent to Yambio.

COTTON.

(a) EGYPTIAN.

(i) *Evelyn's Selected Domains Sakel—Gash Delta.*

Sown over an area of 2700 feddans on Misgas 8 (7E) and 9 (7W) at Tendelai, the product of this large scale propagation will be sown on S.P.S. areas 1949/50.

(ii) *R.D.S. Leafcurl Resistant Sakel—Kassala.*

The yield from the 5 feddan area which was rogued will provide seed for small scale trials.

(iii) *BAR. 14/7—Gash Delta.*

This blackarm resistant Sakel was propagated over 105 feddans at Degein Balag 13. Five feddans were selected and rogued and the resultant seed will go forward to nucleus propagation and varietal tests against main crop Sakel 1949/50. The 100 feddans will provide seed for large scale isolated propagation.

(iv) *BAR. X. 1730L—Gash Delta.*

900 feddans of Misga 3 Mekali were sown with this variety. Five feddans were selected and rogued.

* *Vigna vexillata*, Benth.

(v) *BAR. X.1730L—Gash Delta.*

Five feddans were selected and rogued from the 100 feddans sown at Misga 9A (E) at Tendelai. Seed from this area will be used in varietal tests against main crop 1730.

(vi) *BAR. 4/16—Abdel Magid.*

Eight feddans were sown with this variety to provide seed for large scale propagation on the Gash Delta and varietal trials against the main crop 1730 on the Gezira.

(b) *AMERICAN.*

(i) *BAR. SP. 84—Abu Habil.*

The propagation of this variety over 50 feddans yielded 620 rotls per feddan. A small quantity of the seed has been distributed to Equatoria and the balance is earmarked for bulking in isolation in Kordofan Province.

(ii) *BAR. 7/8—Abu Habil.*

This Bar. SP. 84 selection yielded well, 780 rotls per feddan from 45 feddans. The seed will also be sown in isolation in Kordofan Province 1949/50.

APPENDIX I.

Gezira Variety Trials 48/49.

Variety	Bar Genes	G. R. F. (Blackarm severe)			Turabi (Blackarm mild)			Hag Abdulla (Blackarm medium)		
		Seed Cotton lbs. per acre	Lint. lbs. per acre	G.O.T.	Seed Cotton lbs. per acre	Lint. lbs. per acre	G.O.T.	Seed Cotton lbs. per acre	Lint. lbs. per acre	G.O.T.
DS		1290.6	413.0	32.0	1246.4	428.8		731.5	217.3	29.7
DS ₁		1262.0	403.8	32.0	1226.2	424.3	34.4	658.9	197.0	29.9
DS ₂		1003.3	321.1	32.0	1223.6	427.0	34.6	654.1	199.5	30.5
DSS mixed		1024.9	330.0	32.2	1194.4	420.4	34.9	654.4	200.9	30.7
XAG		1736.2	600.4	35.1	1357.9	499.7	35.2	1120.0	370.7	33.1
XAT		1708.9	603.2	35.3	1317.6	487.5	36.8	1100.0	365.5	33.5
BAR. XL	B ₂	1977.9	710.1	35.9	1250.2	462.6	37.0	1227.4	421.0	34.3
BAR. XL ₁	B ₂	2087.8	730.7	35.0	1256.7	460.0	36.6	1242.6	418.8	33.7
BAR. XL ₂	B ₂	1961.0	680.5	34.7	1250.6	451.5	36.1	1284.1	427.6	33.3
BAR. 4/5	B ₂	2046.0	679.3	33.2						
BAR. 14/7	B ₂	1627.2	476.8	29.3	1199.1	417.3	34.8	1207.0	385.0	31.9
RDS		767.6	261.8							
BAR. 4/16	B ₂ B ₃	2198.6	736.5	33.5						
JR. 1530		1470.9	553.1	37.6						

At the 5 per cent level the significant differences for seed cotton were 169.2 and 137.2 lbs per acre at the G. R. F. and Hag Abdulla respectively. At Turabi there was no significance. Owing to pressure of work all replications were bulked before ginning so no analysis of lint yields and G.O.T. was possible.

XAG, XAT, BAR, XL, BAR. XL₁, BAR. XL₂, BAR. 4/5 and BAR. 4/16 are all X. 1730 derivatives. DS, DS₁, DS₂, DSS mixed, RDS (Leaf curl resistant Sakel), BAR. 14/7 are Domains Sakel, derivatives. JR. 1530 (Hairy 1530 strain) DS₂, RDS and DSS mixed all had primary infection of blackarm.

APPENDIX II.

KEY TO SYMBOLS USED IN THIS REPORT.

Varieties :—

B. 31	..	.. A blackarm resistant Upland type from Uganda.
BAR. NT. 96	..	NT. 96 carrying B ₂ (American Upland).
BAR. NT. 205/43	..	Selected from Uganda SP. 20 and homozygous for B ₂ .
BAR. SP. 84	..	The blackarm resistant component of Uganda SP. 84.
BAR. 4/5	..	.. 9th backcross X.1730 homozygous for B ₂ .
BAR. 4/11	..	.. X1730 carrying both B ₂ and B ₃ .
BAR. 4/16	..	.. " " " " " " "
BAR. 7/8	..	.. Blackarm resistant SP. 84 carrying B ₂ and B ₃ .
BAR. 14/1	..	.. 5th backcross BAR. 2710 x Domains Sakel homozygous for B ₂ .
BAR. 14/7	..	.. 7th backcross Domains Sakel homozygous for B ₂ .
BLR. 14/16	..	.. Selections for leaf curl resistance made from BAR. 14/7.
BAR. 1730L	..	.. 7th backcross X.1730A homozygous for B ₂ .
BAR. 1730L Sel. 1		BAR. 1730L which has been " filtered ".
BAR. 1730L Sel. 2		BAR. 1730L which has been " filtered ".
BP. 52	..	.. A direct import from Uganda.
Cambodia	..	.. American long staple imported from Barberton.
Domains Sakel	..	.. A standard variety originally imported from Egypt.
DS1, DS2, DS3	..	.. Selections and re-selections by Evelyn.
Domains Sakel Sel. 1		Domains Sakel which has been " filtered ".
Domains Sakel Sel. 2		Domains Sakel which has been " filtered "
Ferguson	..	.. A hairy Upland obtained from the Phillipines via Trinidad.
JR. 14/5	..	.. Evelyn's Dom. Sakel to which H ₁ has been transferred from Tanguis.
JR. 1530	..	.. Selection from within 1530 for hairiness.
" L " Cotton	..	.. The X1530 — X1730 group of cottons.
Massey's Dom. Sakel (M.D.S.)	..	.. A Sakel variety selected by R. E. Massey.
M.U. 8b	..	.. A hairy Upland from India.

N.T. 58/39 ..	..	A selection from a "Punjab Early" outcross.
N.T. 58/42 ..	..	A later selection of the same type as N.T. 58/39.
N.T. 58/43 ..	..	A later selection of the same type as N.T. 58/39.
N.T. 96/40 ..	..	57 X "Over-the-top", a single plant selection
N.T. 205/41 ..	..	A selection from Uganda S.P. 20.
N.T. 205/43 ..	..	Successor types to N.T. 205/41, carrying B ₂
N.T. 205/45 ..	..	Successor types to N.T. 205/41.
Pump Scheme Strain		Commercial type which originated from Nyasaland Upland.
RDS ..	..	RDS = Leaf curl resistant Domains Sakel.
S/C ..	..	Seed Cotton.
"S" Cotton	..	Domains Sakel.
SFD. — 5 ..	..	A variety of Domains Sakel originally imported from Egypt.
SP. 20 ..	..	A strain imported from Uganda.
SUS. 7/2 ..	..	Blackarm susceptible SP. 84.
Tanguis ..	..	A <i>barbadense</i> type imported from Peru.
Wilds No. 11	..	American Long Staple grown commercially at Zeidab. Large balled early.
X. 1530 ..	..	A bushy variety selected by A. R. Lambert from Sakel.
X. 1530A ..	..	A successor type to X 1530.
X. 1530 Hairy	..	A hairy selection found in X. 1530 by H.E. King.
X. 1730 ..	..	A bushy variety selected by A. R. Lambert from Sakel.
X. 1730 A ..	..	The successor type to X. 1730 at present grown commercially.
X. 1730K ..	..	A reselection of 1730A type.
XAG. ..	..	X. 1730A Gash grown.
XAT ..	..	X. 1730A Tokar grown.
XL ..	..	Same as BAR. 1730L.
PSS ..	..	Pump Scheme Strain.

Genes.

B ₁	..	..	..	A dominant weak blackarm resistant factor from Uganda B. 31.
B ₂	..	..	..	A dominant strong blackarm resistant factor from Uganda B. 31.
B ₃	..	..	..	A strong, partially dominant blackarm resistant factor from <i>punctatum</i> .
B ₄	..		..	A strong, partially dominant blackarm resistant factor from <i>punctatum</i> .
H	..	..	..	A hairiness factor from Tanguis.
H ₁	..	..	..	A hairiness gene from Tanguis.
H ₂	..	..	..	A hairiness gene from <i>arboreum</i> .

ENTOMOLOGICAL SECTION.

General Survey of Insect Pests of Crops.

by

R. C. Maxwell Darling, H. S. Darling and B. B. el Shafie.

PESTS OF COTTON

BOLLWORMS. (VARIOUS SPECIES).

Blue Nile Province.

(a) Gezira Scheme.

The incidence of pink bollworm (*Platyedra gossypiella*), in green bolls examined from sampling areas during the season under review was markedly less than in the preceding season. Tayiba had the severest infestation, followed by Turabi, G.R.F. and Abdel Galil. Infestation in other blocks was low.

The table below shows the sum of the average monthly total of damaged bolls for the 6 blocks sampled for the last twelve seasons from November to February. Figures in thousands per feddan :—

Season	Total
1937/38	43.7
38/39	40.5
39/40	23.1
40/41	38.8
41/42	8.9
42/43	46.3
43/44	16.5
44/45	12.2
45/46	10.2
46/47	9.8
47/48	25.8
48/49	17.0

Egyptian bollworm (*Earias insulana*) was worse than usual in all sampling areas, but infestation was considerably less in green bolls than pink bollworm except at Turabi. There are indications that Egyptian bollworm was more numerous in areas which had been sprayed with DDT.

(b) White Nile Schemes.

No boll examinations were made, but all bollworms were reported present in the crop throughout the schemes.

Northern Province — Zeidab.

Damage by pink bollworm was generally of average severity. The pest was found in very small numbers in samples examined towards the end of July. It then showed an increase in August and the following month. By October the infestation was heavy amounting to 57.3 per cent as against 30 per cent for the corresponding period last year and 50 per cent for the year before last.

In spite of this severe attack it is believed that the pest caused less damage than was thought, as more than 80 per cent of the total crop was picked by the middle of September.

Damage by Egyptian bollworm to bolls was slight but it caused a fair amount of shedding and damage to growing points. Sudan bollworm (*Diparopsis castanea*) was absent throughout the season and attack by American bollworm (*Heliothis armigera*) was negligible.

Kassala Province.

(a) Gash Delta.

Pink bollworm appeared only in March in bolls examined from Degein, Mekali and Wad Sharefei. Attack was 8.4 per cent, 3.6 per cent and 5.6 per cent respectively. As in the preceding season Egyptian bollworm attack in bolls was patchy and low. It was responsible however for damage to buds and growing points. Sudan bollworm caused normal damage which reached an average of 9.3 per cent in March.

- b) Tokar Delta and Mechanised Crop Production Scheme, Gadambaliya.
See separate reports.

Kordofan Province.

(a) Nuba Mountains.

Boll examinations were confined to Kadugli area. Pink bollworm incidence showed a definite increase over that of last year throughout the season with a peak of 29.1 per cent damage in December. Egyptian bollworm infestation amounted to 10.8 per cent in December as against 15.5 per cent in December 1947. Damage by Sudan bollworm was negligible. Egyptian and Sudan bollworms were responsible for causing some shedding of buds and bolls during August and September in Kadugli area.

(b) Abu Habi Scheme.

All bollworms except American were present in the crop. By the end of November Egyptian bollworm damage was 17 per cent of the green bolls examined.

Equatoria.

Egyptian and pink bollworms were both recorded from Yambio and Maridi but their incidence was generally light.

COTTON THRIPS. (*Hercothrips* spp.).

Gezira.

Attack by *Hercothrips fumipennis* and *H. sudanensis*, though causing considerable leaf fall in the central and southern Gezira, was much less than in the last season.

White Nile Schemes.

Damage was severe locally at Um Gerr and Dueim, slight elsewhere. Towards the end of November about 1/3 of Wad Nimr crop and parts of Dueim and Um Gerr became severely defoliated.

Gash Delta.

The attack, which was general throughout the Delta, was of average intensity. It began much earlier than usual (first week in September) and went on unabated throughout October but ended in November with the advent of the cold weather. *H. fumipennis* was the dominant species with very few *H. sudanensis*. Damage by the latter started in the second half of February from one centre of infestation in misga 4 of Tendelai canal. The infested area was sprayed with DDT which checked the attack to some extent.

WHITEFLY. (*Bemisia gossypiperda*, M and L).

Gezira.

This pest was probably more numerous than usual particularly in the north.

White Nile Schemes.

Whiteflies were present in large numbers on cotton at Fatisa and few at Dueim in September. At Abdel Magid the population was high on cotton and lubia in November.

Gash Delta.

Whitefly population was less than usual this year.

COTTON JASSIDS (*Empoasca libyca*, de Berg).

Blue Nile Province.

See report on Jassids for Gezira Scheme.

Without exception White Nile Schemes were severely infested.

Northern Province—Zeidab.

Jassids were present in the crop throughout the season without causing damage of importance.

Gash Delta.

First rotation cotton on all canals showed signs of heavy attack in patches which in the aggregate was not of any serious consequence. The second rotation was undamaged except at misga 10 (c) on Hadaliya.

Equatoria.

Widespread infestation on cotton in both Maridi and Yambio areas resulting in general reddening of leaves and leaf shedding in October. Extent of damage was reported as difficult to assess.

COTTON APHIS (*Aphis gossypii*).

Tokar Delta.

This insect was the major pest of cotton in Tokar Delta, causing *asal* on an unprecedented scale. The *asal* was first observed in January in a small area in Hod Mant. The attack there showed considerable increase in February and by March it became universal throughout the Delta. It is estimated by the Senior Inspector of Agriculture that the potential yield was reduced by 200—300 rotls per feddan through the ravages of this pest.

COTTON STAINERS (*Dysdercus* spp.).

In the Kadugli area of the Nuba Mountains, damage in green bolls throughout the season was the lowest for years. The highest incidence in the native crop was 1.0 per cent severe stain in November, with an equal attack on Kadugli Farm in December. *D. fasciatus* is usually the dominant species, but *D. superstitiosus* appears to be on the increase.

In the experimental cotton on Abu Hahl Scheme *D. fasciatus* was present in some numbers during the season.

There was in Equatoria a very heavy population of stainers on cotton in December.

COTTON CAPSIDS.

Attack this season by *Helopeltis* and *Lygus* bugs on cotton in Equatoria was generally light.

Creontiades pallidus.

Northern Province—Zeidab.

Creontiades were first noticed in the dura crop at Aliab in the south about the last week in July. They spread northwards appearing at Timeirab at the beginning of August. By mid-August the pest was responsible for 33 per cent of bolls shed in the field. Generally the attack throughout the crop was severe amounting probably to an average loss in yield of one kantar of seed cotton per feddan. Small unreplicated spraying trials, carried out with DDT and Gammexane, seemed effective in controlling the pest, resulting in an increase in yield in the sprayed areas.

Tokar Delta.

See Tokar report.

COTTON FLEA-BEETLE. (*Podagrica puncticollis*, Weise).

Attack on seedling cotton was light in the Gezira except at Saadalla and Soriba where it was severe, necessitating the dusting of several numbers with Agrocide 3 at the end of August.

In all other cotton growing areas it caused a certain amount of damage.

COTTON STEMBORER (*Sphenoptera gossypii*).

Gash Delta.

It was present all over the Delta particularly in first rotation cotton causing some casualties in October and November.

PESTS OF DURA

LOCUSTS.

Desert Locust (*Schistocerca gregaria*).

The country was all quiet until June when there were four reports of swarms in the Northern Province near Shendi. There were further reports in July from the Northern Province near Shendi, in Khartoum Province near Wad Ramli, and in Darfur Province near Kuttum. Reports probably refer to one or two swarms. These swarms disappeared without breeding in the country in spite of the favourable conditions that prevailed during the rainy season especially in the central Sudan.

A local outbreak developed on the Red Sea littoral in April 1949 (see Pest Control).

Tropical Migratory Locust. (*Locusta migratoria—migratorioides*)

None reported.

DURA STEMBORER. (*Sesamia cretica*).

It was prevalent in the Northern Province as usual, the attack in Shendi District being nearly the same as in the previous season. In the Nuba Mountains (Kadugli area) this pest was found in all varieties of dura with an average maximum incidence of 65 per cent stems attacked in September. Attack became light at the end of the season. In the Gash Delta and M.C.P. Scheme *Sesamia cretica* was present throughout the season without doing much damage.

As usual stemborer attack was noticeable in all the remaining dura growing areas of the Sudan with variable incidence from light to severe.

DURA ANDAT BUG. (*Agonoscelis versicolor*, F.).

This pest did little damage.

DURA MIDGE (*Contarinia sorghicola*, Coq.).

In the irrigated area in the Gezira damage by this pest in December was variable—severe in the Centre Group, light in the North, Messellemia and South Groups and negligible in the K.C.C. On the White Nile Schemes, midge damage was mentioned on late-sown areas in November.

In the Nuba Mountains the pest was found on several varieties of early maturing duras grown in the vicinity of Kadugli during September and October.

LYGAEUS PANDURUS.

This pest was commonly observed on dura in the Gash during the season. Its attack was of no material significance except at one locality west of Kassala Town. Here the crop was attacked in the milk stage by large numbers of this pest and was destroyed. The attack probably came from the surrounding *Calotropis* bushes which are a favourite wild host of the bug.

DURA APHIS. (*Aphis sorghi*, Thbld.).

This insect was noticed on dura throughout the country. In Kadugli area its attack was severe in September.

GRASSHOPPERS.

In Amadi District (Equatoria Province), *Homorocoryphus nitidulus* was reported to have caused about 25 per cent loss of dura in some plots in November.

For Gedaref District, see special report.

BIRDS.

This season, damage by the Sudan Dioch (*Quelea quelea aethiopica*) in Kassala and Blue Nile Provinces was generally light, though unusually severe in parts of Kosti District particularly in the *harig* south of Jebel Megeinis and at Um Darag and Wad el Igeili in the Fung District.

Other grain eating birds made a severe attack on dura in the area round Fama in Kadugli District, and Eastern and Central Districts near Khor Abu Habi (Kordofan Province). A bird called *Um Uweidat* (unidentified) caused widespread damage in Dar Hamar of Western Kordofan.

PESTS OF VARIOUS CROPS

PULSES.

In Northern Province lubia and haricot beans (*Phaseolus vulgaris*) were attacked by whitefly, jassids, American bollworm and thrips on a scale similar to that of last year. The combined incidence of these pests resulted in poor yield of beans on Aliab Pump Scheme.

In parts of the Gezira, lubia showed slight damage by the same pests throughout the season. Cowpeas and gram sown on an experimental basis on the M.C.P. Scheme suffered very severe damage from *Mylabris* spp. in September. Galerucid and *Epicauta aethiops* beetles caused some damage to velvet beans sown on Kadugli Experimental Farm.

OIL SEEDS.

The Sesame Webworm Moth (*Antigastra catalaunalis*) attack on sesame grown on the M.C.P. Scheme about the end of July was fairly severe. In the Nuba Mountains area the pest was present on the crop in the usual way without causing serious damage. In Kordofan as a whole infestation of Sesame Seed Bug (*Aphanus litoralis*) this season was not serious anywhere.

TOBACCO.

At Yambio Experimental Farm (Equatoria) tobacco sustained some damage from grasshoppers in August and by cutworms at the end of September. Both pests were easily controlled by handpicking.

CUCURBITS.

The melon stemborer (*Apomecyna binubila*), the melon ladybird (*Epilachna chrysomelina*) the melon bug (*Aspongopus viduatus*), the orange-red leaf beetle (*Rhaphidopalpa* spp.) and the melon fruit fly (*Dacus* spp.) were prevalent in native cultivations in Khartoum Province throughout the season and caused some damage.

FRUIT TREES.

The incidence of Hibiscus mealy-bug (*Phenacoccus hirsutus*) and Guava mealy-bug (*Ferrisia virgata*) in gardens in Khartoum and Northern Provinces was generally less severe than in the last season.

PEST CONTROL

LOCUST CAMPAIGN.

As it was considered that the swarming cycle was over, the organization was confined to the appointment of 100 mounted scouts in Kutum District of Northern Darfur as any swarms were likely to come from the west, and the use of 3 trucks at Shendi for scouting during the period June 15th to August 15th.

On the Red Sea Littoral patrolling of the outbreak area was started towards the beginning of November. The area from Port Sudan up to the Egyptian border was completely dry throughout the winter and no locust activity was seen there. South of Port Sudan as far as the Eritrean frontier, rainfall, though generally patchy, was particularly heavy between Aqiq and Karora. In this area incipient swarming was located about the end of March in *dukhn* cultivations near the Sudan—Eritrean border. Baiting was started immediately and, at Jebel Halibai where the infestation was bigger, the Eritrean Desert Locust Survey team cooperated fully with our staff in checking the outbreak. As baiting in *Pennisetum* was somewhat difficult, a few hoppers escaped and flew by the end of April. A few hatchings also occurred at some places in *Pennisetum* cultivations in the Tokar Delta.

PINK BOLLWORM.

As in the preceding years routine inspections of used cotton sacks for freedom from seed cotton were undertaken by staff of this section at ginneries in the Gezira and Nuba Mountains.

Cotton seed sunning as a control against resting larvae was carried out at Zeidab, Tokar, Khartoum and Nuba Mountains.

The seasonal inspections of the Blue Nile riverain cultivations in the vicinity of the Gezira Scheme were done in the usual way during June and August to see if the bamia (*Hibiscus esculentus*) dead season was being observed. Big areas of illegal bamia were noted on both banks of the Blue Nile and police had to be called in to get the plants removed.

COTTON FLEA-BEETLE.

Early in August a power duster was sent out to Wad Naaman Block to dust about 1,052 feddans of early sown cotton with Agrocide 3 against flea-beetle attack. During September cotton in Wad Saadalla Block, Soriba and Experimental plots on G.R. Farm were also dusted. Results were satisfactory.

COTTON STAINER BUGS.

Destruction of stainer bugs on tebeldi trees (*Adansonia digitata*) by the application of paraffin spray was confined this season to Kadugli area only. A single campaign from the beginning of June to the end of July was carried out. In all 257 trees were treated with very satisfactory results. During the dry season about another 120 trees with big concentrations of the bug were either dusted or sprayed with various insecticides of which Agrocide 3 was the most promising.

DURA ANDAT BUG.

Control operations were carried out in Gedaref and Rufaa Districts and in the southern Gezira. The method followed was the same as in previous years: shaking infested trees, sweeping up the bugs on the ground and then covering with earth. The infestation in all these areas was lighter than usual.

MEALY BUGS.

Routine destruction of Hibiscus and Guava mealy bugs, by pruning of heavily infested branches, burning them and then spraying the trees with Volck was carried out throughout the season in Khartoum Province, parts of Shendi District and Wadi Halfa.

FIELD RATS.

Destruction on a limited scale of *Arvicanthis testicularis* was effected in Khartoum Province, parts of Shendi District and parts of Southern Gezira District. Zinc phosphide bait was used.

BIRDS.

See report on bird control.

OBSERVATIONS AND MINOR EXPERIMENTS

Emergence of pink bollworm moths from the resting—stage at Shendi.

Seed from Zeidab was caged on 7.11.47. Emergences were as follows :—

November 1947	..	..	..	5,530	
December	..	..	..	1,244	
January 1948	..	..	..	203	
February	..	..	..	89	
March	..	..	..	116	
April	..	..	..	79	
May ..	..	..	..	No data	
June	..	..	..	"	
July ..	..	..	..	7	} Rainy Season
August	..	..	..	18	
September	..	..	..	3	
October	..	..	..	0	

The results are similar to those obtained in other years at Shendi viz :—

- (a) Though collected at the end of the season only a small percentage of larvae were resting larvae.
- (b) The majority of the resting larvae became adult before the rainy season.

The results are different from those of the Gezira and Khartoum, where there is a high percentage of resting larvae at the end of the season, of which the vast majority become adult during the rains.

Insecticides for stainer control.

Dysdercus fasciatus is attacked in the Nuba Mountains when the bugs are congregated on the tebeldi trees, by spraying with paraffin. This season DDT, benzene hexachloride and "Pyrethex" were tried. The latter, to be effective, had to be used at too high a rate to be economic and was abandoned.

BHC proved more promising than DDT and should be considerably cheaper than spraying with paraffin.

PLANT QUARANTINE

The Plant Quarantine Service, with stations at Khartoum, Wadi Halfa and Port Sudan continued to work on the usual lines. Nothing of particular interest occurred during the year.

Research on Cotton Jassids (*Empoasca Libyca*)

By J. W. Cowland and A. D. Hanna.

A. JASSID INCIDENCE DURING THE DEAD SEASON.

The survey undertaken in the northern Gezira during the dead season (May to August) 1947, was repeated in 1948. Observations were also carried out at Abdel Magid and on the White Nile before the rains closed the road. Several new host plants were found on which jassids can breed or can survive as adults.

Those on which adults and nymphs were found include henna (*Lawsonia alba*, L.) and sidr (*Zizyphus spinachristi*, Willd.) and those on which only adults have been found include the following :—

<i>Sunt</i> trees	..	..	..	<i>Acacia arabica</i> , Willd.
<i>Canna</i> flowers	..	..	..	<i>Canna indica</i> , L.
<i>Euphorbia</i>	sp.			
Lime trees	..	..	..	<i>Citrus medica</i> , L.
<i>Neem</i>	..	..	..	<i>Azadirachta indica</i> , A. Juss.
<i>Tamrhindi</i>	..	..	..	<i>Pithecolobium dulce</i> , Roxb.
<i>Heglig</i>	..	..	..	<i>Balanites aegyptiaca</i> , Del.

A few nymphs were found on *sunt* and *heglig* in July and August but they were considered to be *Erythroneura* sp. They did not survive to emerge as adults so that their identity could not be finally established.

During May jassid nymphs were numerous on egg plants, (*Solanum melongena*) the wild *Solanum dubium* (*gubbein*) and *Hibiscus esculentus* (*bamia*) wherever these plants were growing ; but adults were not very abundant.

Towards the end of July adults were becoming more numerous on *sunt* trees, henna and *Solanum* and nymphs were numerous on henna, egg plant, and *Abutilon glaucum*.

During August jassids were leaving the gardens and arrived on cotton as soon as it appeared above ground ; nymphs were found on the 28th August so that eggs, which at the shortest time take 6 days to hatch, must have been laid by the 22nd August.

Similar conditions prevailed at Abdel Magid where jassids were mainly found on *Solanum dubium*, a very common weed in the forest plantation and watered areas. It is probable that, had jassids then been known to be able to survive on *sunt* trees larger numbers might have been found on these trees. The biology of jassids on *sunt* trees during the dead season may be of great importance. On guava trees jassids can only be found when young growth is present just previous to and during the rains.

B. EXPERIMENT IN CONTROL DURING DEAD SEASON.

1. *Spraying of gardens.*

An attempt was again made to exterminate jassids on all vegetation on the west of the main canal in Laota and Kab El Gidad Blocks and Badr house in Meilig Block. The vegetation in all gardens was sprayed with 0.5 per cent DDT emulsion on June 19th and 26th and on July 4th. The hedges were sprayed and also the *sunt* trees as high as the sprayer would reach. It was while spraying the *sunt* trees that adult jassids were noticed falling from the top of the trees. This was the first time that their presence on these trees had been discovered.

These gardens were kept under observation ; only an occasional nymph was found after the spraying, but adults appeared a few days after each spraying on some of their host plants, and at the end of July, nymphs and adults were increasing on henna hedges. In the gardens which were not sprayed, on the east of the main canal in Laota and Turabi blocks, jassids continued to be plentiful on egg plants and *Abutilon* throughout the summer.

2. *Effect on incidence on cotton.*

Regular nymphs counts were taken every 10 days from a large number of cotton fields on the west and east side of the main canal in the northern Gezira, where spraying of perennially irrigated gardens on the west side had been carried out during the dead season.

The reduction in the numbers of jassids on the cotton due to spraying the gardens on the west side of the main canal was not appreciable.

C. INCIDENCE ON COTTON IN RELATION TO PROXIMITY OF GARDENS.

Counts were made of the number of jassid adults and nymphs from 200 plant holes, taken at random from 10 angais of a tenancy from cotton numbers adjacent to gardens and distant from gardens in the northern Gezira. These gardens had not been sprayed.

Results showed that in most cases larger numbers were nearest the house gardens at all dates. The exceptions were edge cotton numbers on the west and north end of canals, adjoining the desert. The numbers of jassids on cotton on the eastern side, except on Hannina 12, do not appear to have been increased by movement from river side sagias, not very distant from these numbers.

D. EFFECT OF RAIN ON JASSIDS.

1. Experimental.

In the previous season it was shown that up to 90 per cent of jassid nymphs were killed if infested plants were sprayed with water to which fine Gezira soil was added (2 kilograms per 4 gallons water), but that only 14 per cent were killed when water alone was sprayed.

The following experiments were done to test the effectiveness of mud splash.

Tin cones about 17 cms in diameter were suspended on a fixed arm at different heights above ground level. Within the base of each cone a circular cork pad 12.5 cms in diameter was fitted horizontally, and on this was pinned a round of filter paper.

When it rained the mud was splashed up on the filter paper which was removed carefully and dried. The dust was then swept off and weighed. The following table gives the weights of mud splashed on to cones at different heights.

Date of rain	Amount of rain in mms	Weight of dust in grammes at height of cms. from ground.						
		10	20	30	40	50	60	70
9. 8. 48	27.0	1.25	0.57	0.21	0.02	0.005	Tr	—
16. 8. 48	20.8	2.29	0.33	0.12	0.19	0.005	Tr	—
20. 8. 48	16.1	2.60	0.58	0.42	0.24	0.007	Tr	—
3. 9. 48	8.9	0.36	0.29	0.24	0.05	.003	Tr	—
7. 9. 48	50.9	2.80	2.04	0.85	0.12	0.04	Tr	—
12. 9. 48	12.9	1.65	0.80	0.19	0.02	Tr	—	—
24. 9. 48	3.7	0.11	0.10	0.01	Tr	—	—	—
29. 9. 48	18.8	1.15	0.50	0.28	0.07	0.03	Tr	—
17.10. 48	6.4	0.24	0.14	0.58	0.05	Tr	—	—

It is evident that mud splash hardly rises more than 30-40 cms. Where the ground is covered by weed growth, mud splash was found to be very much less ; *gubbein* growing on fallow land supports only a small number of nymphs but when it grows on banks of irrigation canals with a good cover of grass, nymphs are more numerous. Counts of nymphs per 100 leaves on 11th. September on *gubbein* growing over grass and on fallow land were found to be 134 and 5 respectively.

An experiment to test this mud splash theory was done on the farm using egg plant which is a favoured host of the cotton jassid.

Egg plants were sown during the first week of June (heavy rain starts in July) in a plot which was divided into two parts.

- (a) The soil between the plants was covered with broken red bricks so that rain would only produce water splash and not mud.

(b) The soil was left exposed to the direct effect of rain.

The initial infestation of nymphs before the experiment started was 72 in (a) and 80 in (b) per 100 leaves. The results showed that the number of jassids on the egg plants in the mulched plot increased rapidly. Hopper-burn soon became evident and pronounced on the leaves. On the exposed plot the number of jassids increased very slowly till a certain point when the increase became sharp. At this point the height of the plants was found to be 33 cms. which was beyond the range of mud splash.

2. Observations in the Gezira.

The rain storms on the 19th and 22nd. September caused a marked reduction of jassid population as the following table shows—presumably due to mud which plastered the leaves, killing the nymphs.

Rain Storm of 19th. September.

Locality	Date Counted	Nymphs per 200 plant holes	Date counted	Nymphs per 200 plant holes	Remarks
Badr 14	14. 9.48	1,365	20. 9.48	189	Mud Splash on leaves No mud on leaves
" 43	"	492	"	100	
H/Sereiha 50	"	325	"	138	
" 67	"	136	"	471	

Rain Storm of 22nd. September.

Hannina 1	19. 9.48	620	23. 9.48	163	Mud Splash on leaves
" 12	"	474	"	140	
Shobali 1	"	258	"	71	
" 16	"	192	"	16	
Abu Rus 7	"	693	"	40	
Abu Gabal 20	18. 9.48	505	"	13	

It should be mentioned that the mud on the leaves has no residual effect in killing jassids.

E. PARASITES AND PREDATORS.

No parasites and no new predators were noted as giving effective control.

The following coccinellids were found devouring jassid nymphs :—

Coccinella rufescens, Muls.

Cydonia vicina, Muls.

Exochomus nigromaculatus, Goeze.

Also larvae of *Chrysops vulgaris* Sch. and some unidentified spiders.

F. DEGREE OF INFESTATION IN GEZIRA SCHEME.

In the North Group, the number of jassids on cotton was very high at the beginning of the season but they were abruptly reduced directly after two violent storms on the 19th. and 22nd. September in that area and they remained at a lower level than had been forecast.

In the Messellemia Group, the heaviest infestation in the middle of October were the north end of Rukn, Istrahna and Dolga and east side of Nidiana ; spraying started soon after that. By early November the infestation had increased in Wad Sulfab sufficiently to warrant spraying and over 1000 feddans were sprayed between 22nd. and 26th. November.

In the Centre Group a heavy attack was expected in Tayiba East but, on 17th and 20th October, 112 mms of violent rain fell at Azaza house and killed off the jassids and they were very difficult to find in this area after that. The same fact is demonstrated by comparison between the dry Mahmoud area of high jassid infestation and the wet "rain path" from Tebub oil store to the Radma extension which had low jassid infestation. No spraying was done and some relation of jassid to yield may be later found in these areas.

In the South Group, jassids were much more prevalent this season than last season. Wad Naaman and Remeitab were the most heavily infested while Hamad El Nil was no more than last season. A total of 1350 feddans was sprayed in Wad Naaman between 14th November and 25th November.

G. CONTROL MEASURES.

1. *Large Scale Spraying.*

(a) General.

Large scale spraying was again satisfactorily carried out under contract by Messrs Pest Control Ltd. between 25th September and 25th November. Approximately 93,000 feddans were sprayed.

DDT emulsion, DDT wettable powder and DDT paste were all used in the S.P.S. and K.C.C. areas.

In several blocks paired numbers were laid out to compare DDT emulsion and DDT wettable powder against each other.

The spraying started on the White Nile Schemes at Fatisa and Hashaba on 25th September and in S.P.S. North Group on 7th. October and in the K.C.C. on 12th. October and at Abdel Magid on 9th October.

(b) Helicopter spraying.

The helicopter, brought out by Messrs Pest Control Ltd., carried out successful trials in spraying cotton from the air with DDT emulsion. The following tables show the results of the helicopter trials at Turabi.

Gedeia 1. Sprayed October 15th. Counts Taken 18.10.48.

Locality	Speed M.P.H.	Height of spray bar	DDT lbs. per fed.	Jassid nymphs per 100 leaves	Percent- age killed
Gedeia J	Unsprayed	—	—	46.0	—
Gedeia G/H	20	4 ft.	1.66	2.4	95
E & F. A/XX Side ..	40	9 „	1.00	0.0	100
E & F. Tagnet side ..	40	4½ „	1.00	0.8	98
Shagayag 16G	Unsprayed	—	—	127.0	—
„ 16E	Ground Sprayer	2½ „	1.00	1.5	99

Tekeina 3 Sprayed 18th October.

Locality	Height of spray bar	DDT emulsion gallons p.f.	DDT lbs. p.f.
Tekeina 3 A-G ..	9 ft.	3½	1.00
„ H-I ..	9 ft.	5	1.66

A-D were sprayed while the land was being watered. E-I were sprayed one or two days before water opened. Nymphs counts were taken on Tekeina 3 with the following results.

Date	Sprayed from air						Nymphs per 100 leaves. For comparison	
	Tekeina 3						Sprayed by ground sprayer	unsprayed
	A	C	E	F/G	H	I	Abu Wafi 19	Abu Rus 7
16.10.48 ..	Before spraying						19	—
19.10.48 ..	—	—	—	7	11	—	65	35
24.10.48 ..	5	6	8	6	12	5	8	92
30.10.48 ..	2	1	3	2	0	0	—	—
7.11.48 ..	1	1	1	0	0	1	2	109
15.11.48 ..	12	5	4	4	—	—	9	468
29.11.48 ..	22	10	10	9	4	4	10	439
9.12.48 ..	11	5	5	4	4	2	—	—
21.12.48 ..	13	2	4	3	1	0	12	66
1. 1.49 ..	14	9	7	3	2	2	12	41

The trials having proved successful 6759 feddans were sprayed from the air.

2. Experimental.

(a) Preliminary trials with "Pestox".

Small scale experiments with Pestox proprietary systemic insecticides, showed that white fly and jassids are controlled to a considerable extent. Following these trials, two 5 feddans field on the Gezira Research Farm were sprayed on 25th November by Pest Control Ltd. with the two more promising formulations. Results were promising against whitefly but the spraying was done too late as whitefly were already on the down grade. Jassids were effectively killed, but residual effect was slight.

(b) Comparison of the residual effect of proprietary DDT sprays made from emulsions with those made from wettable powder against Jassids on cotton.

The trial was designed to show the effect of sprays on jassid population, not to show yield differences.

Spraying was done on 6th November and nymph counts started on 8th November. Results show that emulsions are superior in residual effect to wettable powder sprays and that the former at 0.1 per cent DDT gave significantly better jassid control on cotton than the latter at 0.25 per cent DDT. None of the emulsions was significantly better than another but there was some difference in the brands of wettable powder.

H. EFFECT OF DATE OF SPRAYING ON YIELD, 1947/48.

Results were not obtainable at the time of the submission of the 1947/48 report and are now given. The following table shows the yield of cotton from all blocks in the S.P.S. + K.C.C. where from 40-60 per cent of the block was sprayed. Some numbers received a dressing of ammonium nitrate previous to sowing the cotton.

	No Manure		Manured
	Sakel k.p.f.	X1730 k.p.f.	Sakel k.p.f.
Unsprayed	2.19	3.24	2.49
Sprayed DDT emulsion.			
October 10th-20th	4.10	—	4.56
„ 21st-31st	4.20	4.24	4.56
November 1st-10th	3.54	4.21	4.63
„ 11th-20th	3.18	4.41	4.12
„ 21st-26th	2.83	—	3.46
Sprayed DDT wettable powder.			
October 21st-31st	3.82	—	(4.69)
November 1st-10th	(3.67)	5.59	(2.41)
„ 11th-20th	(3.80)	—	—

The figures in brackets are of doubtful value as only 15 fields or less were sprayed.

It should be emphasised that these figures are obtained from averaging a number of individual fields which total a large area for each treatment. A fair scatter was thus obtained, but there has been no statistical analysis.

Insect Pests on the Mechanised Crop Production Scheme Ghadambaliya (Kassala Province).

By R. V. Joyce.

DURA.

Establishment of the dura crop proved difficult as in other years. Grasshoppers caused considerable loss to the dura sown in July on the area allotted to participating cultivators at Leiya Workshops, and almost the whole area had to be resown. Grasshoppers, however, were not alone responsible. On the experimental farm at Ghadambaliya there was much damage to July sowings, but the effects were masked by the heavy sowing-rate. *Pnorisa carinata*, Uv. was responsible for most of the damage to seedlings, which were often eaten off to ground level. A certain amount of loss was caused at Leiya workshops by *Aiolopus savignyi*, Kr. which had completed one generation by this date.

No damage occurred to crops sown on *komodob* and, even on small isolated 1 feddan plots on 2nd year *komodob* where heavy damage might be expected, no resowing was necessary.

The damage by *Pnorisa carinata* (an *anis* loving species) is incidental. The practice in opening virgin land for cultivation is to burn the dead grass before the rains. The grasshoppers are driven off by the fire, but recolonise the area as soon as the first rains have brought up a new growth of vegetation. This new growth is disced out, and if the crop is sown immediately, the grasshoppers of necessity feed on the young dura. The grasshoppers die off in August after having laid their eggs and damage to seedlings by grasshoppers in August and September sowings is rare. Owing to the absence of *anis* grass, *komodob* is not colonised by *P. carinata* so that early sowings are safe from attack by this grasshopper.

A. savignyi on the other hand, colonises *komodob* in preference to virgin land. If a year favourable for breeding is followed by a year of heavy May rains, the first generation which becomes adult in July might cause damage to early sowings. It should normally be possible, however, to sow the earliest sowings in early July in such a year, so that the seedlings are well established before the grasshoppers have left their early breeding grounds. This was done in Leiya village during the present season, and on some of the Gedaref *bildat*.

Harvester ants (*Messor* sp.) and weaver birds (*Quelea quelea aethiopica*) destroyed large quantities of seed before germination,

The usual toll of young seedlings was taken by stemborers. *Atherigona* (probably) *excisa*, Thom (Diptera, Anthomyidae) caused most damage, but *Sesamia cretica*, F. (Lepidoptera—Noctuidae) was also common. Both these insects are indigenous to the area, their host plant being *anis*, so that the usually recommended means of control are likely to be of little value. Seedlings weakly in growth succumb most readily to attack, and successful control lies in the establishment of a healthy crop. Attack was most severe on the experimental farm amongst the July sowings on virgin land, where the dry grass had been incompletely destroyed, and the seedlings were suffering from nitrogen deficiency. On *komodob* heaviest damage was to *seluka* sowings, where many young seedlings competed with each other. Amongst the seedlings sown by drill, damage was negligible.

The crop, once established, grew extremely well.

In mid-October locally breeding grasshoppers began to congregate on the crops, and the area was invaded by large swarms of *Aiolopus savignyi*, whose second generation had developed in the drier areas north and west of the scheme. The experimental farm, with its randomised plots of many varieties, provided an admirable opportunity for observing varietal preferences. It is interesting that *Catantops axillaris*, Burm. broadly shows the same varietal preferences as *Aiolopus*. The main varieties eaten were as follows:—

<i>Most favoured.</i>	<i>Eaten.</i>	<i>Least favoured.</i>
Wad Aker Abiad	Feterita Managil	Mugud Ahmer el Khafif Feki Mustahi
Wad Aker Ahmar	Feterita Suki	Wad Fahl
Feterita Maatuk Westland Combine	Dwarf Hegeiri	Dwarf White Milo

In the main areas where blocks of 2,000 feddans of dura were established, grasshopper damage was light, and complete stripping of plants occurred in only a few isolated patches.

Damage was heavy in some of the isolation and bulking up plots and is estimated as follows:—

<i>Variety</i>	<i>Area in Feddans</i>				<i>Estimated loss per cent</i>
Wad Aker Abiad	25				60
Wad Aker Ahmar	25				40
Feterita Maatuk	75				25
Westland Combine	25				20
Dwarf Hegeiri	25				20
Caprock	1				20
Plainsman	1				20
Cody	1				50
Queensland Hegeiri	1				25

Other varieties escaped serious damage. In the larger areas *Aiolopus* caused most of the damage, but in the 1 feddan isolation plots many other species shared the responsibility.

Aiolopus attacks both the heads and the leaves. Amongst the Wad Akers and Hegeiris both are attacked simultaneously, and the effect on yield is serious and at once apparent. In the Feteritas attack is concentrated on the leaves, and it is more difficult to estimate the resulting loss of crop. The leaves of the 75 feddans of Maatuk were badly stripped, but the heads were more or less uneaten. The crop was a first rate one and should have given a record yield, but after the attack many of the seeds in the heads failed to develop, and perhaps 20 per cent of the glumes were empty. This is attributed to the loss of leaves, by grasshoppers, and a consequent interference with transpiration and food supply. Westland Combine belongs to the class where the leaf-damage is greater than the head damage.

The Milos appear to be comparatively resistant to grasshopper attack, as are the Muguds and the Wad Fahl and Feki Mustahi types.

Heavy damage occurred in the experimental farm. The crops here included many varieties sown in July, August and September on virgin land, *komodob* in its third season of cropping, and fallow disced land. Although it was not possible to distinguish between the intensity of infestation amongst the different crops, which were all heavily infested, the worst damage was to August sowings on virgin land—namely the variety-spacing experiments (see p. 154). An estimate was made of the leaf damage to Westland Combine in the various spacings. Ten plants were selected in each sub-plot, and the amount of damage to each leaf estimated. The results are tabulated below:—

				Inter-row Spacings.		
				36"	42"	60"
3/plants/metre	..	..	..	60	48	37
11 plants/metre	..	..	..	52	40	44

The damage is expressed as the percentage of leaf surface destroyed. There was an obvious correlation in the field between the damage and inter-row spacing, but none between damage and within-row spacing. The plants which were attacked most heavily were those suffering from water deficiency. Normally this would be related to spacing, but differences between the within-row spacing were masked by flood water. It is clear therefore, that heavy damage to crops poorly thinned, which has been noted in other years, is related to the density of growth, only in as much as the plant density causes water deficiency.

Congregation of grasshoppers on the crops began in mid-October. The period of maximum feeding by *Aiolopus* and *Catantops axillaris*, the two most important species, is October to early November, by which time *Catantops* has begun to disperse to the grasslands, and *Aiolopus* to the cracks in the soil under crop. The dura crop is most susceptible to grasshopper attack in the milky stage, when the heads are most attractive to both species and when water strain in the plant is greatest and water deficiency in the soil will manifest itself in the drying off of the leaves, a condition favoured by *Aiolopus*.

The earliest sowings on the experimental farm were during the second half of July on land in its third year of cultivation. The heads reached the milky stage in late September and by the second half of

of October, when grasshopper numbers were at their maximum, the seeds were beginning to harden. These July sowings escaped all but minor damage. On the other hand the sowings in late August (25th August on *komodob* and 11-12 September on virgin land) were in flower during this period and the leaves were healthy and green. They also escaped all but negligible damage.

All the areas where damage was severe were sown in mid-August, and the crops were in the milky stage during the period of maximum grasshopper infestation. The local native practice is to sow *bildat* in the first rains, and during the present season sowing was completed well before the end of July. The *harig*, on the other hand, is usually sown during the second half of August. Mugud, a variety little favoured by *Aiolopus*, is the usual variety for *harig*. During the present season little damage was suffered by the local cultivations, in spite of the heavy, and almost continuous infestation of grasshoppers in the dura belt between the Rivers Rahad and Atbara.

A strong case can be made, from the point of view of grasshoppers alone, for avoiding mid-August sowings. Since *komodob* cannot stand late sowing, such land should be sown as early as possible and certainly before the end of July. Virgin land, to avoid damage to seedling dura, should be sown during late August or early September. By this means the crops will not be in the milky stage at the time of maximum grasshopper numbers.

Cultural methods may provide an insurance against grasshopper damage, especially from locally breeding species which congregate on the crop after the grass lands have dried out. But they can give no guarantee against damage by *Aiolopus*, which, if a choice is available, will select the crop it prefers, but, in the absence of a choice will eat any dura present. It is necessary to have available a more direct means of control. Trials were carried out with baits, which indicate that successful control may be expected from the distribution of dry, coarse crushed dura, mixed with Agrocide VII at $2\frac{1}{2}$ per cent by weight. It is recommended that stocks of this bait are held by the M.C.P. Scheme ready to issue to cultivators for distribution by them, in times of emergency.

Trap strips of Wad Aker Abiad surrounding the crop proved effective in concentrating locally breeding species, and spraying trials using Agrocide wettable powder were carried out against such concentrations. Trap strips proved in practice to be difficult to establish, and uneconomical, in that a considerable acreage is prepared for sowing and not harvested. They are further quite ineffective in concentrating *Aiolopus* which is by far the most serious pest. It is unlikely that it will be possible to recommend trap strips as a standard practice, but a further trial is desirable.

As in previous seasons, grasshoppers were the main pests of dura, and no serious damage can be attributed to other insects.

Asal caused by *Aphis sorghi*, Theob. was more common than usual in the district, causing considerable loss of crop in the southern Gabob. On the M.C.P.S. plants were colonised as early as July by winged alatae and in the wetter areas of the scheme heavy breeding took place which resulted in a high proportion of the plants suffering from *asal* in November.

Although there was no visible damage to the heads, it is possible that the loss of large quantities of sugar solution from the plant at this time results in a poorly filled grain, and a poorer return per acre. Mugud was more heavily attacked than other local varieties and Westland Combine was also heavily attacked. The Feteritas were relatively resistant. Colonies of aphids are usually attended by ants, and the possibility of their survival of the dry season through the agency of ants deserves study, in view of the serious damage this aphid has been known to cause in the Gedaref district. Migration by aphids is known to take place over great distances, and it seems likely that a bad *asal* year is one of heavy early rains, when the aphids are able to complete extra generations. *Asal* was especially severe on the irrigated Feterita Suki, grown by Lake Smith.

No damage by *dura* andat—*Agonoscelis versicolor*, F. (Hemiptera : Pentatomidae) was seen this year, but some was reported from the Hawata area. Several colonies aestivated on *Combretum* trees on Jebel Ghadambaliya. They left their hosts in early August, and were not encountered again.

Milky *dura* was damaged by several blister beetles, especially in the drier areas, such as near Jebel el Atshan, where *Mylabris ligata*, Chavr. and *M. bipartita*, Mars. were the commonest species. Their presence in large numbers may be related to the heavy breeding of *Aiolopus* which took place in this area, as larvae of some blister beetles feed on the eggs of grasshoppers.

Other minor pests of milky *dura* included *Pachnoda marginata* Dury, *P. interrupta*, F. and *Rhabdotis sobrina*, G. and P. (Coleoptera : Cetoniidae).

SUNFLOWER.

Germination of sunflower was very good, and the young seedlings extremely healthy, and generally grew away well from the attacks of leaf feeding insects. The most serious pests of seedling sunflower were the grasshoppers *Caloptenopsis insignis clara*, Wlk, and *Catantops axillaris*. No resowing was necessary, and it is unlikely that either species will be sufficiently numerous at the beginning of the rains to necessitate any special steps to be taken against them, when crops are grown on a large scale. On the small 1 feddan plots which were used for the isolation of sunflower varieties, damage to the young leaves was heavy.

Sunflower in its vegetative growth was attacked by few insects and remained extremely healthy until October, when jassid infestation became severe (*Empoasca libyca*, de Berg). The severe leaf scorch which resulted may have some bearing on the poor yield which was given by otherwise healthy plants. In mid-September the grasshoppers *Pyrgomorpha cognata*, Kr. congregated on sunflower, but did little damage. In October the crop was colonised by *Catantops melanostictus*, Wlk and *C. axillaris*; the former fed largely on the leaves and the latter on the flowers, destroying the whole of the back of the head. Since this occurred before the seeds had ripened, it seems likely that the low percentage of full seeds was related to grasshopper damage. Counts

of full and empty seeds from damaged and undamaged heads were made, but the percentage of full seeds (38 per cent) was about the same in each case. Under circumstances more favourable to the growth of the plant the damage by grasshoppers might be more easily assessed. Mr. Moir concludes that the rainfall requirements of sunflower are such as to necessitate very early sowing, so that the crop is ready for harvesting by the end of the rains, namely September. Such a practice should enable grasshopper damage to be avoided. Pests of minor importance include *Anoplocnemus curvipes*, F. (Hemiptera : Coreidae), *Leptocoris griseiventris*, Wests (Hemiptera : Coreidae) and *Eurycorypha* sp. (Orthoptera : Tettigonidae).

SAFFLOWER.

Safflower of the first sowing date (27th July) was heavily attacked in October by a caterpillar resembling the American bollworm. The upper leaves and bracts were eaten and the young bud hollowed out from the inside. The adult larvae survive the dry season in an earthen cocoon just below ground surface, and the adult is expected to emerge in the rains. *Heliothis peltigera*, Sciff. (Lepidoptera : Noctuidae) is recorded as a pest of safflower at Wadi Halfa and this caterpillar may indeed be the same species. It is estimated that at least 25 per cent of the young flowers and fruit were destroyed. The same damage to upper leaves was noted in January on safflower grown at Wad Medani, but no larvae were taken.

At Khor Kafai safflower was badly attacked by an aphid, probably *Macrosiphum jaccae*, L. which is recorded as a pest of safflower in Egypt. This aphid heavily infested safflower at Ghadambaliya in 1947, but was not recorded in 1948. The effect on yield at Khor Kafai was probably serious.

SESAME.

Sesame, on the whole, was a healthy crop, but suffered from attack by *Antigastra catalaunalis*, Dup. (Lepidoptera : Pyralidae) which damaged the leaves and the fruit. Some damage to the vegetative growth was caused by *Catantops axillaris* and *C. melanostictus* especially in the dry areas around Jebel al Atshan, where some fairly serious leaf-stripping was seen.

GROUNDNUTS.

Serious damage to groundnuts was done by termites and by thrips—*Hercotrips fumipennis* which annually causes such severe damage as to render control essential if groundnuts are to be grown. Attack begins at the end of the rains, and continues normally until the plant is destroyed. Successful control has been achieved by spraying with 0.1 per cent DDT emulsion.

LEGUMINOUS AND FORAGE CROPS.

Gram and cowpea were attacked by several blister beetles in October, which destroyed buds and fruit. The most serious pest was *Epicauta* sp.—probably *aethiops* Latr., but *Mylabris ligata* also caused much damage.

Sunn hemp was also attacked by the same species of blister beetle from October onwards. Leaves and pods were also badly attacked by *Urethesia pulchella*, L. (Lepidoptera Arctiidae) which continued breeding until December. This promises to be a serious pest if sunn hemp is to be grown on any scale. A leaf feeding beetle *Hyllisia* sp. (Coleoptera Lamiidae) was found in fair numbers feeding on sunn hemp.

COTTON.

Rain-grown cotton, during the present season, kept remarkably free from pests. Termites took their usual toll. Flea beetles—*Podagrica puncticollis*, Wse. (Coleoptera : Halticidae) caused a certain amount of damage, but were not nearly as numerous as in the year of poor early rains—1947. During the last two seasons, thrips attack has been light, while in 1946 the crop was virtually destroyed by this pest. In September *Pyrgomorpha cognata* invaded the crop and caused light damage to the leaves. Heavier damage occurred in October through *Catantops melanostictus* and *C. axillaris*. A second generation of *P. cognata*, which had bred in the crop, continued leaf damage in November. Egyptian bollworm was common and caused considerable boll shedding.

Control of Grain Eating Birds.

By

C. E. Wilson.

A. THE SUDAN DIOCH (*Quelea quelea aethiopica*) IN THE BLUE NILE—RIVER ATBARA AREA.

In this area the work was divided into two parts :—

(1) Scouting to obtain information during 1948 in preparation for a control campaign.

(2) Control measures during January—March 1949.

(1) Gathering Information.

Scouts ranged over the whole area from the Blue Nile to Kassala during the latter part of the rains to find out the time, and extent of nesting. Poor rains in the normal main nesting areas prevented growth of the grasses whose seed provides most of the birds' food. Probably

as a result of this the swarms crossed to north western Abyssinia, and nested near Cafta (Lat. 14.00 Long. 37.00). This could not be visited, but the information which could be obtained indicated that nesting was on a reduced scale. The swarms reappeared in the Blue Nile—Rahad area much later in the winter than usual.

(2) *Control Measures.*

These were carried out in the Rahad—Dinder—Blue Nile area*, during January—March 1949. Roosts in riverside forests were attacked at night with high explosives. Good results were obtained, and large numbers of birds were killed.

Estimates of kills are difficult to arrive at, but it is considered that up to 75 per cent of the population in some roosts was destroyed. Considering that the roosts this year have been less compact than usual, the results may be considered as very satisfactory, particularly in view of the fact that this was our first experience of a large scale campaign.

The control measures were carried out by a self contained mobile explosives team, which made three expeditions (each lasting 2-3 weeks) to the areas, one in January, one in February, and one in March. In each expedition all suitable roosts were attacked and between the expeditions intervals were left to allow remnants of swarms to re-group, so that they could be attacked again.

Details of expeditions are as follows :—

(a) January Expedition.

<i>Roosting Sites Attacked</i>					<i>No. of 50 lb. Gelignite charges used.</i>
Wad el Ais on Blue Nile	..	..	..	..	35
Zumurka on Blue Nile	..	..	..	..	157
Um Namil on Dinder	..	..	..	..	42
Kaja on Dinder	..	..	..	..	30
Beida on Dinder	..	..	..	..	47

					311 = 7 tons

A swarm roosting in scattered bush at Lakandi on the Blue Nile was not attacked as the site was unsuitable. In early February this swarm moved to Launi on the Blue Nile where it was reinforced by survivors from the Zumurka explosion. At the same time survivors from the Dinder explosion regrouped into a fresh swarm on that river.

(b) February Expedition.

<i>Roosting Sites Attacked</i>					<i>No. of 50 lb. Gelignite charges used.</i>
Launi on Blue Nile	..	..	..	..	300
Abu Rura on Dinder	..	..	..	..	83

					383 = 8½ tons

* In the area bounded by latitudes 12°30', 13°20' N and longitudes 33°.50', 35°E.

At the end of the February expedition, there remained a small swarm north of Sennar in an unsuitable site, while a few swarms in difficult places were reported from the Rahad. In addition survivors from explosions were scattered along the Blue Nile and Dinder.

(c) March Expedition.

<i>Roosting Sites Attacked</i>				<i>No. of 50 lb Gelignite charges used.</i>
Gezeir on the Blue Nile	..	..	..	155
Malawiya Agib on the Rahad	..	..	..	226
Hamad El Sid on the Rahad	..	..	..	129
Beida on the Dinder	..	..	..	55

				565 = 14 tons

At the beginning of this part of the campaign a large swarm was reported on the Blue Nile at Gezeir, and medium swarms at several places on the river Rahad; at the end no swarms remained which were large enough or dense enough to be worth attacking.

(d) Summary of Campaign.

It will be more satisfactory to judge the campaign after the rains when the quantities of birds appearing in the nesting zones have been estimated; but, from observations up to the end of the campaign, it would appear that a high measure of success has been obtained at less cost than was anticipated, as a considerable amount of explosive remains unexpended.

The bird swarms appeared to have been destroyed and scattered in a very satisfactory way, leaving no large swarms, though survivors of swarms which had been attacked were still to be found in the vicinity of their previous roosts. Only in the southern part of the River Rahad was any quantity of birds reported, but these were comparatively minor swarms in inaccessible places. If however all these birds collected together again they could still cause a large amount of damage, and it would be prudent to be in a position to continue the campaign against swarms which may appear in the dry season roosts next winter.

The only alteration in methods of carrying out the explosions which was made during the campaign was a slight reduction in the spacing distance of the explosive charges. The original spacing was 20 yards between charges, but this was reduced to 15 yards during the first period, to produce a greater shock in roosts, in which the trees were somewhat high, and this distance was retained.

B. REPORT ON TOUR TO EXAMINE STATUS OF GRAIN EATING BIRDS
IN EQUATORIA. AUGUST—SEPTEMBER 1948.

During August and the early part of September, the Inspector Bird Control made a tour of some areas of Equatoria and Bahr el Ghazal Provinces, to obtain information on the species of birds causing crop damage in the various districts, to investigate the extent of present damage, and the areas in which the success of any future extension of grain growing might be prejudiced by bird damage.

Unfortunately the only time available for this investigation was before the nesting period, during the rains, when the large swarms are not normally much in evidence. The investigation was also made more difficult by the fact that the birds spend a considerable portion of their time in areas which are only inhabited by occasional wanderers and stock keepers, who have no interest in birds. (Individuals capable of giving reliable evidence are also few and far between). However it is considered that the main outline of the status of bird pests has been obtained, so that if any control measures are required in the future, the more detailed investigation needed could be put in hand without waste of time.

As conditions on the east and west of banks of the Nile appear to be dissimilar, the two areas are dealt with separately.

THE EAST BANK (JUBA, TORIT, NAGICHOT DISTRICTS).

The most serious and widespread of the bird pests in this area is the Sudan Dioch (*Quelea quelea aethiopica*), additional serious damage being caused by the Ruwenzori V Marked Weaver, (*Textor cuculatus feminina*) and various species of doves, local damage also being caused by the Black billed Sparrow Weaver (*Plocepasser mahali melanorhynchus*)

The Fire Crowned Bishop Bird (*Euplectes hordeacea hordeacea*) is a very common and striking species throughout most of the area, but does not appear to be responsible for any important loss, though it does attack eleusine. The Dura Bird, or Red Bishop Bird (*Euplectes franciscana*) also occurs in smaller numbers.

There are also several species of yellow weaver birds, which are unimportant.

Sudan Dioch.

The position with regard the Sudan Dioch in this area would appear to be as follows :—

Nesting takes place during September, as it does in the north, in an area of suitable bush, mainly *kitr*, (*Acacia mellifera*), running from the Lafit hills, passing north of the Didinga hills, and east to about Karoma (Long. 35 Lat. 5) and bounded on the north by the hills of the Boma Plateau, and the swamps of the Upper Pibor. This area seems to be very suitable for these birds, and appears to contain large swarms.

During the dry season, from November to March, they appear in various places south of this zone. One locality is the Kinyeti valley, west of the Lafit hills, where they roost in large quantities in long grass by the river. Another is to the north of Tirangole, where trees in the roost may be broken by the weight of the swarms, as occurs in the Blue Nile area.

In the absence of reliable information about the movements of swarms during the early rains, this is presumably similar to what happens in the north, when the large swarms normally split up into smaller flocks, which scatter widely over the country side, and are not especially obvious. Towards the middle and end of the rains, large flocks appear

in the vicinity of cultivated land in the Torit-Kapoeta area, apparently moving gradually from west to east, as they are reported in the area of Liria from May to June, near Jebel Lafon from July to August, and between Tirangole and Kapoeta in September and October. This would appear to be gradual migration prior to nesting. During the course of the investigation swarms of these birds were seen between the Boya hills and Kapoeta, at the end of the first week in August, feeding on grass seeds at some distance from cultivation.

Ruwenzori V-Marked Weaver. (Textor cuculatus feminina).

This species is of widespread occurrence in the Torit-Kapoeta area, though its range is in general more northerly than that of the Sudan Dioch. It is common in the swamps bordering the Nile. It was seen in some numbers from the steamer from Shambe southwards at the end of July and also near Torit in early August. It nests in trees in and near the swamps, and the nesting season covers a longer period than that of the Sudan Dioch, apparently extending from July to September. A very dense colony in a *Borassus* palm, in flooded Toich country near Yirrol was seen in the second half of August. This bird apparently inflicts severe damage at times.

Black Billed Sparrow Weaver (Plocepasser mahali melanorhynchus).

The Black Billed Sparrow Weaver is common, and causes damage in some areas; it occurs in small colonies, and makes permanent shelters or houses, which resemble nests; consequently its movements are confined to their immediate vicinity.

Area of Jebel Lafon.

As Jebel Lafon is a possible site for a mechanical cultivation scheme, a special visit was made to it.

Quelea visits this area in large numbers during the dry season, but does not nest in the vicinity. Prior to nesting the birds are present from July to August, when they depart for nesting. They then re-appear in large numbers in November, and stay until about March, during which time they roost in the long grass in the vicinity of the perennial rivers Koss and Kinyeti. At this latter time there are no crops to be harmed, but in normal years they cause considerable damage prior to nesting. If it is desired to increase the grain production in this area, the simplest and cheapest method of avoiding damage by birds might be to sow a dura that ripens a little later than normal, during September, which would then avoid the bird swarms. To be sure of this however, accurate records would need to be obtained for several seasons.

General.

The birds in the Torit-Kapoeta area would appear to cause a severe annual loss of crop, since such a large proportion of the population spend their time scaring birds. At the beginning of August there seemed to be a bird scarer with a long stick, and a supply of damp clay for sling-ing perched on a platform in about every two feddans of crop.

THE WEST BANK (JUBA, MARIDI, YAMBIO AND RUMBEC DISTRICTS).

The Sudan Dioch.

This bird appears to be a widespread and tiresome pest throughout this area, as cultivators consistently pick it out as being a destructive bird. There would however appear to be no area of country suitable for large swarms to breed, and I was unable to find out from where they come, though they appear in some numbers as far south as Maridi during November. The possibilities would appear to be that they come either from the Torit-Kapoeta area, or from the swarms in the north, near the Bahr el Ghazal and Bahr el Arab. In either case they must come from a considerable distance.

Concentrations of these birds occur in the Toich country near Rumbek and Yirrol, but although they do some damage, they do not appear to be a really serious pest in this type of country. From the information available it does not seem that the swarms of *Quelea* on the west bank of the river are such as to threaten seriously any large scale grain production schemes.

The Ruwenzori V Marked Weaver.

This bird is common in the areas approaching the marshy toich areas, and can at times inflict some damage. It would probably not prevent large scale cultivation on the toich areas, though, as with the preceding species, it is difficult to evaluate this from one visit.

A yellow weaver. This species nests in some quantities in suitable localities. In some areas it may cause damage, but it is probably not a serious pest.

There are also large numbers of the Red Bishop bird, and Lado Taha Bishop bird on the toich grasses, but they mostly confine themselves to eating grass seeds.

On both banks of the river there appears to be considerable damage from several species of doves and in some areas they would appear to be the worst pests. Doves however are so common and widespread throughout the country, that there would not appear to be any possible centralised method of control.

Note on the Sorghum Midge in the Khor Abu Habil.

by

W. S. Richards.

The Khor Abu Habil rises in southern Kordofan and flows during the rainy season in an east-north-easterly direction. Dura is grown (a) on the Abu Habil floods round Um Ruaba and Rahad (b) on rain often by *harig* on the uncanalised areas and (c) from 1945 to 1947, by irrigation on the Abu Habil Scheme. The area lies in the 400-500 mm. rainfall belt.

In 1947, the yield of irrigated dura (Feterita Managil) was reduced to a quarter of the estimated total through the attacks of the midge *Contarinia sorghicola*, Coq. (Cecidomyiidae). The cultivation of dura on the Abu Hahl Scheme was abandoned in 1948 save for experiments.

The adult midge appears in the rains and is most active in the cool of the day. It lays its egg in the flowering spikelets and the larva feeds on the developing ovule. In the rains the life cycle can be completed within a fortnight. Aestivation takes place in the spikelet as the prepupa. A wild Sorghum, *addar*(1), appears to be the only alternative host. Though rain or flood grown dura had been grown in the area for many years, little dura midge damage occurred prior to 1946. In 1945 dura was first grown by irrigation on the Rahad end of the scheme. The variety was Feterita Managil derived from selected seed from the Managil rainlands.

In 1946, Feterita Managil was grown on both the Rahad and Semeiha ends from seed grown on the Rahad end of the Scheme in 1945. *Addar* appeared for the first time and the crop suffered from dura midge. On certain fields 40-50 per cent of the tillers were affected and the experimental plots were very severely damaged. No variety escaped attack (including Dwarf White Milo, Feterita Managil, Bergali Ahmer, Kullum, Karanika, and Zinari). The damage was estimated as being 20 per cent of the total yield and was most severe at the Rahad end. The tillers were mainly affected and damage was most apparent on heads ripening in October and November and which flowered during September.

In 1947, the dura seed was imported from the Managil rainlands but, by this time, *addar* had established itself throughout the Scheme. Moreover, though the rogued selected seed grown on the Rahad end was free from *addar*, the commercial seed used on the Semeiha end was not. As *addar* flowers before dura, the dura midge was able to build up a large population before the flowering of the main crop dura. Feterita Managil, a tillering variety, produces heads over a long period. The midge was able to complete several generations on the crop and ultimately destroyed it.

It was observed that if the dura was sown at the normal planting time the primary heads were the least attacked while the damage was greatest on the later tillers. Little infestation was observed on plots of late-sown dura, though isolated late-flowering heads in the centre of heavily damaged holdings were surrounded by very large numbers of adult midges.

During 1948, some dura was grown under irrigation in an area not previously under cultivation and about a mile to the south of the *addar* infested areas. Very little midge attack occurred. In Feterita Managil the main heads were attacked while the later flowering tillers escaped. So far as other varieties are concerned, in heads harvested from plots A, C, and D, Mugud and Dwarf White Milo escaped almost entirely. Kullum, Karanika, and Safra Koya were slightly affected. Feterita Managil, Hemeisi Abyad, and Bergali Ahmer suffered much damage

(1) This grass, which is closely allied to the cultivated Sorghums, has been tentatively named *Sorghum arundinaceum*, Stapf.

while Feterita Maatuk, and Abu Sabein were almost destroyed. These varieties were grown together. Mugud which was least affected flowered in October, Feterita Maatuk during September. Dwarf White Milo which was severely damaged in 1946 escaped damage almost entirely in 1948 although it is an early maturing variety. No variety escaped entirely although certain varieties had only slight damage although grown side by side with severely damaged varieties of similar flowering date.

Rain-grown dura on the sands to the north of the clay plain suffered severe midge damage. This damage decreased rapidly with distance from the *addar*-infested clay plain. On the clay plain itself outside the Scheme, rain grown dura—mainly Feterita Managil—escaped damage when planted away from *addar*-infested areas.

At Um Ruaba, where dura is grown on land left after the Abu Habl floods recede, dura—mainly Zinari, maturing by the end of December—showed signs of dura midge attack while Safra which was only beginning to mature by the end of January was completely unaffected.

So far as the *addar* on the Abu Habl Scheme is concerned the main heads of true *addar* type escaped with little damage. Such larvae as were found were dead and very few in number suggesting that the majority had completed their development during the previous rainy season. Subsidiary heads on the main stalk and the dura—*addar* crosses—both of which flowered later—were heavily damaged and contained large numbers of aestivating larvae, usually only one per seed but heads have been found in which two or three larvae per seed were not uncommon.

These facts suggest that the time of maximum infestation is after the flowering of the *addar* but before the onset of winter. The effect of weather on dura midge infestation in the Sudan is not known. It may be that in 1948, the absence of rain and the hot dry winds in early October suppressed the infestation (similar cases have been reported from the U.S.A.) and the association of the late flowering with low infestation may be merely due to the weather prevailing. The high October rainfall of 1947 may be significant. It seems probable that the cessation of infestation is due not to direct extermination of midges but to the larvae passing into the aestivation phase.

The amount of dura midge damage on *addar* was fairly uniform throughout the Semeih end of the Scheme and no patch of *addar* examined escaped. The dura midge was not found on *anis* grass which does not appear to serve as a host.

Addar is distributed throughout the Scheme and on a strip running along the edge of the clay plain just north of Ahmed North Canal. There is very little *addar* present apart from this on or around the Semeih end of the Scheme. The Rahad end was not examined in any detail. On those fields which were effectively cultivated in 1946 and 1947, the natural grass (i) is regenerating but slowly and they are covered with a moderate stand of *addar* and dura-*addar* crosses.

(i) *Anis* (*Sorghum purpureo-sericeum*) and Um Chirr (*Brachiaria obtusiflora*)

In the uncultivated areas, scattered stands of *addar* are found whose arrangement and position suggest strongly that they are the remains of old threshing floors. North of Ahmed North Canal there are large stands of *addar* on the clay plain. Some are growing surrounded by dense grass but the majority suggest they are derived from seeds of *dura* threshed on the edge of the clay plain and from old cultivated areas. The *addar* does not appear to invade uncleared areas which still retain their original grass cover.

Control measures proposed follow standard American and Australian practice and are supported by the evidence above.

- (1) Sow good seed of uniform type which has not been exposed to the risk of outcrossing with *addar*, and prevent the spread of poor type and *addar* type seed by destroying all debris from threshing floors and destroying all heads left unharvested.
- (2) Prevent all *addar* from flowering until the flowering period of the *dura* crop within one kilometre of the area in which *dura* is to be grown, paying particular attention to the windward side. Rogue early *dura* heads.
- (3) Due to difficulties of watering it is not possible to sow *dura* so as to flower before the main period of *dura* midge infestation. It is therefore suggested that a late maturing variety be sown as late as possible to escape the tail end of midge infestation.

More information is required on the distance to which *dura* midge infestation may spread from an infested to an uninfested area, the climatic conditions governing infestation, and the effect of weather on fighting and on the apparent relative immunity of certain strains of *dura*.

It should be mentioned that *addar* occurs with *dura* in other parts of the Sudan without serious midge damage taking place. Why *addar* should apparently have such a bad effect in the Abu Habi Scheme is not known.

Preliminary Survey of the Crop Pests of the Kordofan Sands.

by

W. S. Richards.

I. DUKHN. (*Pennisetum typhoideum*).

In the seedling stage grasshoppers cause damage, principally *Catantops melanostictus*, Wlk. and *Oedaleus senegalensis*, Kr., and to a lesser extent *Pyrgomorpha cognata*, Kr. On the sands they may destroy sowings entirely over large areas; none of these grasshoppers are important pests of seedlings on the Gedaref clay plains.

Millipedes also destroy seedlings. They are said to appear in three year cycles. Large numbers of small millipedes were seen at Um Ruaba in 1948, indicating the possibility of an outbreak in 1949. Poison baits would be worth a trial. Repellents applied to the seed might protect it in the critical period.

In the milk stage, various kinds of *sumpti* eat the developing seeds. This damage may be the cause of *dueih*, a poisonous gummy exudate. The most important *sumpti* is the adult beetle *Rhinyptia reflexa*, Burm. (Rutelidae) which has destroyed large areas of dukhn round Um Ruaba in Eastern Kordofan and reduced the general dukhn yield of this district by an estimated 40 per cent. The growing of awned dukhn might give some protection against this pest.

The bug *Calidea natalensis* may also destroy extensive areas of dukhn in the milk stage. It can be driven off the crop by smoke.

Various insects may cause widespread damage but rarely destroy the entire crop. On new land, certain insects, principally the beetle *Zophosis posticalis*, Deyr., (Tenebrionidae) eat through the stems at ground level. Stem-borers may completely destroy young seedlings under six inches high. If the plant is slightly bigger, it develops normally until the head is about to emerge, then the sheath dries, head-atrophy follows, and all side shoots atrophy. This may be due to the attacks of *Atherigona* sp. This fly lays its eggs on the seedlings and the larvae burrow into the stem and attack the growing point. As tillers are developed, they in turn are attacked. In mature plants little serious damage occurs. The stem sometimes turns red. At least two species of lepidopterous caterpillars have been found in mature dukhn stems, also beetle and fly larvae, but these may be secondary invaders. In mature stems, the caterpillars appear to attack the stem between the second and third internodes. When disturbed they retreat to the base of the burrow. Their presence is sometimes indicated by a smaller hole half-way down the burrow and by frass between the leaf sheath and the stem. Developing heads in the milk stage may be attacked by *sumpti* of minor importance—the adult Cetoniid beetles, *Pachnoda interrupta*, F. and *Protaetia stolata*, Oll. A caterpillar of an unidentified moth burrows under the grain on unripe heads and destroys it. There is also considerable abortion of developing grains which is not due to out-crossing as the florets adhere firmly to the head. This may be due to the attacks of unidentified thrips and heteropterans which swarm round the head in the milky stage.

II. DURA.

Like dukhn—this also suffers from the attacks of grasshoppers, millipedes and *Zophosis* in the seedling stage, and from *sumpti* in the milk stage (but not *Rhinyptia*).

III. WATER MELONS.

In the four leaved stage seedlings may be completely destroyed by the adults and larvae of the beetle *Epilachna chrysomelina*, F. (Coccinellidae) and the adult beetles of the genus *Asbecesta* (Galerucidae). Suggested control measures are a close season for melon growing during the late spring and early rains and hand picking. Dusts might be worth investigation.

Young fruits just after setting, and sometimes the whole plant, may be completely destroyed by *Aspongopus viduatus*, F. (Pentatomidae).

Hand picking should be a practicable method of control and dusts might be worth investigation.

Grasshoppers, mainly *Pyrgomorpha*, and *Zophosis*, may also cause damage to young plants.

IV. GUM.

The only serious pest of this crop is the tree locust *Anacridium moestum*, Serv. This defoliates the trees and may cause serious loss of production. No control measures are known at present. The absence of definite breeding centres and the erratic movements of the swarms makes organised spraying difficult. There are no concentrated breeding areas, swarms move by night and may cover up to 50 miles before alighting.

V. RED SESAME.

Young seedlings may be destroyed by the grasshoppers which attack dukhn, *Catantops* being mainly concerned, and by millipedes.

Young shoots are attacked by the sesame webworm (caterpillars of *Antigastra catalaunalis*) which feed on the growing point under a web. The crop will grow away from an attack if the rains are good. If the rains are poor the pest destroys the flowers and ruins the crop. Badly attacked shoots are usually distorted in a manner reminiscent of virus attack. This pest prevents sesame growing over large areas that are otherwise suited to it. A quick growing variety of sesame might enable the plants to escape most of the damage.

The disease *marad el dam* causes severe damage. It apparently occurs in at least two forms, one caused by a bacterium and one by a fungus.

Stacked sesame is attacked by the seed bug, *Aphanus littoralis*, Dist. (Lygaeidae), which feeds on the seed. The oil content of the seed is reduced and the resultant oil is bitter. Severe damage may occur in bad years.

In red sesame the upper shoots mature first so that a field may be cropped over a period of a couple of months. The mature stems are cut while still green, allowed to wilt for a day or two and then piled, heads inwards, in cylindrical stacks. These stacks remain for about a month while the pods dry out and shatter. The seed is then shaken out of the pods on to the sand from which it is separated by winnowing.

Adult seed bugs and nymphs migrate into stacks of newly cut sesame. They may be attracted by scent as I have found them most numerous in those stacks which lie up wind. They are certainly attracted to large dark objects. Within the stack, the bugs appear to migrate down towards the base in the heat of the day. Eggs are almost exclusively laid on the sand under the stack. In large stacks—18 ft. across and 2½ ft. deep—egg laying took place to a depth of about 3 ft. from the edge of the stack. In smaller stacks 6 ft. in diameter, egg laying took place over the whole area covered by the stacks. The onset

of cold weather checks egg production though some still takes place. Apparently the bulk of the infestation arises in the stacks themselves. As stacks dry out or are threshed, migration occurs from one stack to another.

Agroicide 3 dust (B.H.C.) is very lethal to the seed bug. It is best applied as follows. Twenty four hours after the stack has been started, lifting up the lower layers will show if there are many bugs present in the stack. If this is so, dust between the lower layer of sesame and the sand at the rate of say three cigarette tins, or a half a pound of dust for a pile 6-8 feet across. This appears to prevent egg laying and kills adults and nymphs when they come down to the base of the pile to escape the heat of the sun. The powder may be blown in with a bellows blower or dusted through a piece of gauze on the end of a stick. The object is not to dust the entire pile but to put a dense layer of dust on the surface of the sand under the stack. Pretreating the ground is less effective since much dust is blown away by the wind and the process of making the stack buries most of the dust in the sand. An obvious and heavy kill should occur twenty four hours after treatment. DDT dusts seem equally effective but take four or five days to produce an obvious kill. They may be more persistent. All sesame stalks should be burnt on the same day as they are threshed. If possible, stacks should be located outside sesame fields at least 100 yards from the wilting areas.

VI. GROUNDNUTS.

Millipedes may destroy the crop in the early stages. Termites destroy individual plants when mature. The creeping varieties are less affected since the termite damage is rarely severe enough to kill the entire plant.

VII. COWPEA, BAMIA AND OTHER VILLAGE VEGETABLES.

Seedlings are attacked by millipedes and flowers by Mylabrid beetles. Hand picking for Mylabrid beetles is not satisfactory owing to their immense numbers.

VIII. ONIONS, TOMATOES, CITRUS, ETC.

At Bara, onion thrips damage has been controlled satisfactorily by one spraying of 0.1 per cent DDT emulsion.

Tomatoes, egg plant and other Solanaceous plants appear badly effected by eel-worm. There is distortion of the roots, lumpy nodules and subsequent withering. Guava and citrus are attacked by mealy bugs.

Research on Cotton Pests in Tokar Delta.

OCTOBER 1948—MARCH 1949.

by

D. W. Mollison*

The River Baraka rises in Eritrea and flows into the Red Sea at Tokar, near the Sudan—Eritrea boundary, where it expands into a delta of some 150,000 acres. The river flows during July and August and the amount of land which is flooded varies greatly from year to year both in area and in the degree of soaking the land receives. Cotton, dura and dukhn are sown in September and the cotton crop is harvested from February to May.

Attention has been drawn in recent years to the large amount of buds and small bolls which are shed early in the season. Investigations were therefore undertaken to try and find out the causes of this shedding and whether it could be prevented.

I. NOTES OF COTTON PESTS OBSERVED.

Bollworms American	..	<i>Heliothis armigera</i> , Hb.
Egyptian	..	<i>Earias insulana</i> , Boisd.
Pink	..	<i>Platyedra gossypiella</i> , Saund.
Bugs. Shedder Bug	..	<i>Creontiades pallidus</i> , Ramb.
Cotton leaf-shedder bug	..	<i>Campylomma nicolasi</i> , P. & R.
Cotton jassid	.. ..	<i>Empoasca libyca</i> , de Berg.
Cotton Stainer bug	..	<i>Dysdercus spp.</i> } Small numbers
Green stink bug	..	<i>Nezara viridula</i> , Lf only
Cotton Aphis	.. ..	<i>Aphis gossypii</i> , Glov.
White fly	.. ..	<i>Bemisia gossypiperda</i> , M. & L.
Others. Cotton leaf worm	..	<i>Anomis flava</i> , F.
Termites	.. ..	
Locusts	..	<i>Schistocerca gregaria</i> , Forsk.

- A. American and Egyptian bollworms were responsible for most of the earliest shedding (see attached diagram), they were fairly numerous from mid-December to mid-January, and again from

* By arrangement with Messrs. Pest Control Ltd.

mid-February to mid-March. American bollworm was also seen in considerable numbers in the heads of dura during December. Egyptian bollworm caused considerable distortion of cotton plants by eating out the terminal buds. Pink bollworm was observed very infrequently in ripening bolls during March and later.

- B. From the last week of November to the third week of December *Creontiades pallidus* was seen occasionally on dura, dukhn, and cotton, mostly as adults. Towards the end of December considerable numbers of first instar nymphs were found in dura heads, up to twenty five nymphs being found in one head. Before the end of the year the dura was harvested, and the numbers of the pest on cotton increased until, at the middle of January they were at a maximum, largely as adults or late instar nymphs ; thereafter they decreased rapidly until, in February, they were practically non-existent. At the maximum there were rarely more than a dozen per plant, occasionally three or four in one bud. Large numbers were not found in dukhn. At the end of January there were several first instar nymphs in the rain dukhn in Kartut 6 while one adult was found on the cotton. On the dukhn north of the delta and up Khor Baraka none could be found during February. On the 8th and 22nd February at Aqiq about 40 miles south of Tokar, a few adults and third instar nymphs were found on difra grass (*Echinochloa colona*), and a single nymph on dukhn growing there owing to the unusual rains.
- C. *Campylomma* was present in small numbers early in November ; it subsequently increased but was never numerous enough to cause crop damage.
- D. The cotton jassid was present in very small numbers during November, increasing during December. Counts on December 31st showed an average of rather over 100 nymphs per 100 leaves on plots not sprayed with DDT ; on Tonak 21, with repeated spraying, jassids were absent ; on Tonak 24, with single sprayings, the average was 35 nymphs per 100 leaves. Numbers increased during January. At the beginning of February, on the controls on Tonak 24 a count showed 179 nymphs per 100 leaves. In March there was much visible hopper burn, but all along the plants appeared strong enough to carry the jassid population without serious loss of crop.
- E. In the middle of January *Aphis gossypii* increased locally, but was causing no appreciable damage to plants ; by the middle of February it was numerous enough to cause serious *asal* (honey) in the lusher growths of Eglim 2, Tonak 24, Fedda 14 etc. Thereafter it increased rapidly until at the end of March there was 100 per cent infection of the plants throughout the delta causing very serious damage.
- F. Whitefly in Tonak 21 was first seen on December 3rd, and occasionally within the next fortnight ; by the end of December it was becoming fairly well distributed in the thicker green growths of cotton and the first signs of whitefly *asal* were visible in the sheltered positions

of two experimental plots. Nowhere except on very sheltered, well grown plants did the whitefly develop in any number, but the northern sections of the experimental shelters had patches of *asal* which considerably reduced the crop of individual plants.

- G. *Anomis flava* was present throughout, increasing from early November ; in March there was considerable holing of the leaves of some plants, with no doubt some loss of vigour.
- H. Termites were present but caused negligible damage in the areas studied. They are often an important pest.

II. EFFECT OF VARIOUS TREATMENTS ON YIELD.

A. Treatments.

The following treatments were randomised in each of 6 Blocks in different parts of the delta.

- | | | |
|-----------------------------------|----------------|---|
| 1. DDT sprayed | 3- 5 November | } 0.1% DDT emulsion at 100 galls. per feddan (1 lb. DDT per feddan). To control <i>Creontiades</i> . |
| 2. " " | 10-17 " | |
| 3. " " | 25-26 " | |
| 4. " " | 9-10 December | |
| 5. " " | 4- 5 January | } 0.01% naphthylacetic acid with 0.01 % Lissapol N at 100 galls. per feddan. This might prevent shedding. |
| 6. Hormone sprayed | 12-13 November | |
| 7. " " | 25-26 " | |
| 8. " " | 14-15 December | |
| 9. Matting shelter round sub-plot | | } In case shedding was caused by the strong wind. |
| 10. Topping the plants on | 21-22 December | |
| 11. " " " " | 27 January | } To see if this would reduce shedding. |
| 12. Controls. | No treatment. | |

B. Results.

Yields were taken from 5 Blocks. Treatment 5 gave much the highest yield on the average, but the results were not significant, owing to the high standard error. It is evident that under the extremely variable conditions at Tokar, a very large number of replicates are needed.

Bud charting and collection of sheds indicated that neither the hormone treatment, nor the first four DDT treatments nor the topping had any appreciable effect on shedding.

Indications are that the shelter provided by the matting did reduce the amount of early shedding ; but the conditions produced taller plants than outside and a large population of whitefly and aphid which probably accounts for there being no increased yield from this treatment.

C. *Unreplicated Treatments.*

Three quarter-feddan plots were treated as follows :

- (1) Sprayed 6 times with 0.1 per cent DDT emulsion on November 5th, November 17th, December 8th, December 23rd and January 1st.
- (2) Sprayed 4 times on December 1st, 3rd, 6th and 8th with sodium dihydrogen phosphate at the rate of 20 rotls per feddan (equals 12 rotls P_2O_5). This was to test whether addition of phosphate would diminish shedding which might be due to excess of nitrogen and consequent excessive vegetative growth.
- (3) Control untreated.

The DDT treatment yielded 73 per cent and the phosphate treatment 16 per cent over the control. No conclusions can be drawn, but the figure for DDT is suggestive.

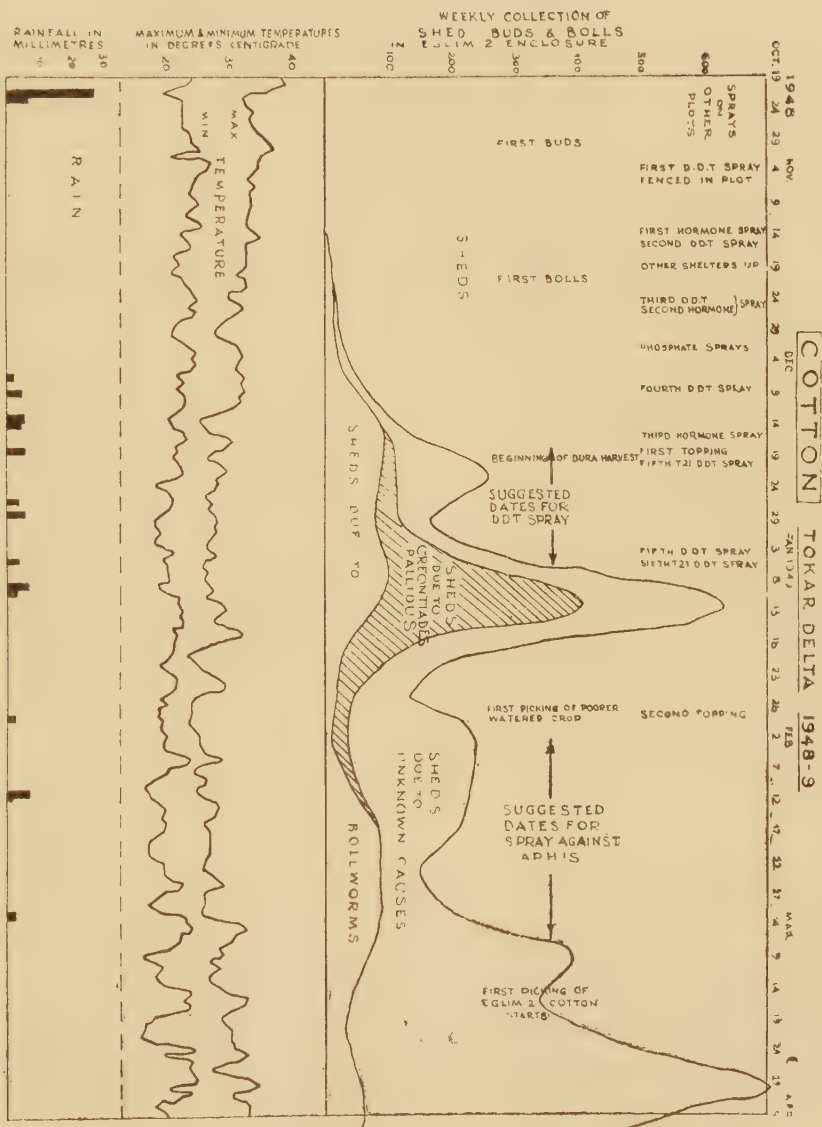
III. OBSERVATIONS ON SHEDDING.

One of the 6 blocks of the replicated treatments was used solely for bud charts of plants in the various treatments. The plot enclosed by the matting screen was used for extended observations on shedding, since the shed buds and small bolls were not blown away by the wind, and the actual number shed by a known number of plants could be collected and analysed for cause of shedding.

The enclosed plot in this block had a lower screen (1 metre high) than in the other blocks. Nevertheless the screen altered conditions with the results that whitefly and aphid were more numerous than outside, and some young bolls went mouldy and were shed before they lost the corolla. The results which are shown in the diagram are not therefore from typical cotton. Sheds were also collected at random in different parts of the delta, but only fresh material was examined. The proportions of shedding from various causes was reasonably similar in the case of random collections and the enclosed plot.

If the bud or boll had a hole eaten into it, the damage was classified as bollworms. Owing to the uncertainty of distinguishing between the Egyptian and American bollworms, subdivision was not made. Sheds by *Creontiades* were regarded as definite only when its yellow excretions were visible. All other sheds were classed as unknown.

Analysis of data from the enclosed plot and generally in the delta indicate that, up to the end of January when the bottom bolls were fully grown, about 40 per cent of the sheds came in the unknown class, 27 per cent were due to bollworms and 33 per cent to *Creontiades*. Later on shedding due to unknown causes increased greatly and this was doubtless due mainly to aphid.



SOIL RESEARCH SECTION

by

T. N. Jewitt, T. A. Jones and K. R. Middleton.

I. INTRODUCTION.

The senior staff have all made more or less extensive tours away from the station, investigating the soils of the south and extreme west. The Soil Survey Officer has surveyed three areas for irrigation development in Blue Nile Province.

Our main lines of work have been much the same as last year. Pedological studies have been made in Darfur and Bahr el Ghazal Provinces and in Equatoria. Fertility studies on the soil of Equatoria and on the cracking clays of Kassala Province and the study of soil nitrogen in the Gezira have continued. The Walkley Black method of measuring soil organic matter has been thoroughly tested on a range of soils, and will be used next year in the study of serial samples from the G.R.F. rotation plots. The study of soil organic matter has also been approached by the measurement of carbon dioxide evolution (G.R.F. rotation plots) and the behaviour of soil nitrates has been studied both by detailed sampling and by the consideration of the results of many years routine samplings.

2. METEOROLOGY.

Meteorological data over a long period have been reviewed in connection with this year's premature opening of the cotton bolls. This winter has been unusually cold, but the minimum temperatures in December and January are not the lowest recorded. On the other hand 08.00 hours saturation deficits at G.R.F. have been the lowest recorded in the period from 1935/36 to the present season. This is not however true generally of the other Gezira stations. Nor were saturation deficits low in the season 37/38 when similar symptoms of premature and bad boll opening were recorded.

Table 1 shows the general rainfall distribution at G.R.F. and over the commercial area.

TABLE 1.

Rainfall in mm.

Period	G.R.F.		29 Block house rain-gauges in commercial area.	
	1948	1919/44	1948	1927/44
March	—	—	}	34
April	—	3		
May	20.3	10		
June	70.3	32		34
July	150.5	137		133
August	97.1	143		133
September	97.3	55		57
October	11.1	14	}	15
November	—	1		—
Total 1948 ..	446.6	396		390
Total 1947 ..	250.3			304
1st July to 15 August ..	223.0	219		179
16 August to 31 August 48	24.6	61		19

The presowing rains between July 1st and August 15th were about normal, the previous year's rainfall was subnormal. The early rains, that is those before July 1st, were heavy. The heavy September rainfall at G.R.F. was not general over the Gezira, though some Blocks recorded very heavy rain in the first half of this month.

Table 2 gives a few other meteorological data for G.R.F. for the crop year under review.

TABLE 2.

	Max. Temp.		Min. Temp.		Rel. Hum.		Evap. Piche	
					2 p.m.	2 p.m.	8 a.m.	8 a.m.
	Av. 1948	Mean 19/42	Av. 1948	Mean 19/42	Av. 1948	Mean 1922/42	Av. 1948	Mean 1919/42
May 1948	41.8	41.0	22.2	23.7	15	15	20.1	20.3
June "	38.2	39.7	23.4	24.4	31	22	15.0	18.6
July "	37.2	35.6	22.3	22.5	34	38	13.7	11.7
August "	33.9	33.5	22.2	22.0	49	49	7.6	7.1
Sept. "	35.0	35.8	21.6	22.0	41	39	8.2	8.3
Oct. "	37.1	38.5	20.5	21.9	23	23	11.6	11.9
Nov. "	36.2	36.8	17.1	18.2	18	16	14.2	14.9
Dec. "	33.3	34.5	13.9	15.2	20	17	12.4	14.4
Jan. 1949	33.7	33.9	13.0	14.2	19	16	15.3	15.3
Feb. "	33.6	35.4	12.9	15.1	13	12	15.6	17.9
March "	38.8	38.4	17.5	17.7	8	8	19.4	21.2
April "	40.5	41.1	20.0	20.9	5	9	23.4	23.0

3. SOIL RECONNAISSANCE AND SURVEY.

A. *Blue Nile Province* (Blue Nile Area).

One large area of c. 30,000 feddans, of which c. 20,000 should be irrigable has been surveyed on the scale one hole per 200 feddans. The area, near Rufaa, is on the east bank of the Blue Nile and field examination and laboratory results both show the land to be of the same type as the main Gezira plain. The distribution of sodium values is given below.

Sodium Value Range	No. of Holes
0-10	5
11-15	8
16-20	38
21-25	63
26-30	32
31-35	3
36-40	0
40-45	1

76 per cent of the holes have sodium values in the range 0-25 inclusive. This is a very favourable distribution. It is beginning to appear that there may well be room for more development on the east bank of the Blue Nile than was formerly believed to be the case.

B. *Kassala Province* (Ghadambaliya).

Holes were dug over the area of the Mechanised Crop Production Scheme to test the uniformity of the soil and to allow us to decide on the need for a detailed soil map. The soils are dark greyish brown,

very heavy clays with uniform profiles to six feet except for an increase in the number and size of calcium carbonate nodules with depth. The soils are cracking clays with a low salt content. They differ radically from the cracking clays of the Gezira plain; the salt content is much smaller and increases fairly steadily with depth, while many Gezira profiles show a minimum salt content at some point in the upper six feet of profile. The sodium values of Gezira soils are grouped about most frequent values in the range 20-30. The Ghadambaliya soils have most frequent sodium values in the range 6-10. The mechanical analyses differ for the two soils, 50-60 per cent is the usual range of clay (.002 mm) in Gezira soil, while the Ghadambaliya samples have around 70 per cent clay. The pH values of the latter soils are lower than that of Gezira soils, doubtless in large part a consequence of their lower sodium values.

The validity of the sodium value criterion for alkaline soils rests upon the soils having similar exchange complexes. The exchangeable calcium in Ghadambaliya samples is 50-60 mg. equivalents per 100 g. and this is of the same order as Gezira samples.

The following table gives analytical data for two holes sampled in 6" steps.

TABLE 3.

Depth	S & G %	C.S. %	F.S. %	Silt %	Clay %	Salt %	Na value	N ppm	Ca m.e.g.	CaCO ₃ %	pH.
C11B14C 1 Step	3	3	14	8	71	.05	3	400	57.2	3.2	7.90
2 "	3	4	15	8	70	.06	6	370	45.4	3.0	7.95
3 "	3	3	17	7	71	.06	8	430	38.7	3.4	8.05
4 "	2	2	16	9	71	.07	10	420	47.5	3.7	8.30
5 "	2	2	17	7	71	.08	12	350	50.4	2.4	8.30
6 "	1	3	16	8	71	.09	13	350	48.3	2.9	8.50
7 "	2	3	17	5	74	.09	13	330	72.7	2.7	8.55
8 "	2	3	15	6	74	.11	13	320	75.3	2.5	8.50
9 "	2	3	16	5	74	.12	14	300	66.5	2.6	8.65
10 "	1	2	15	6	76	.18	14	290	63.3	2.3	8.30
11 "	2	1	16	6	75	.19	15	240	58.9	2.7	8.40
12 "	2	1	15	6	75	.22	16	240	56.3	3.2	8.40
C6B5A 1 Step	2	4	15	8	70	.06	5	450	58.7	1.5	8.05
2 "	3	4	17	8	69	.07	8	470	55.0	1.4	8.30
3 "	2	5	15	8	70	.08	11	410		2.2	8.25
4 "	3	5	14	10	69	.09	14	380		4.3	7.95
5 "	3	6	15	6	70	.10	15	340	49.6	2.7	8.10
6 "	2	3	13	9	72	.13	16	330	49.3	2.1	8.40
7 "	1	3	14	9	73	.16	17	310	49.3	2.0	8.35
8 "	2	4	15	6	73	.21	17	270	51.4	3.4	8.20
9 "	2	3	16	12	66	.22	19	260	54.3	4.0	8.35
10 "	2	3	16	7	71	.25	18	250	58.4	3.7	8.50
11 "	3	3	10	15	69	.28	19	240	62.6	4.5	8.35
12 "	3	4	14	7	73	.33	18	210	65.2	6.3	8.20

C. Darfur Province.

This most westerly province has been visited by a soil chemist for the first time.

There are several important soils in the central parts of the province. They are :—

Aeolian Goz Sands.

Sedentary Soils on basement complex rocks.

In most holes bedding is very clear and fine mica is abundant. The Truog phosphate values are very high. Total nitrogen contents are low, but values much exceeding those in the above table were found in profiles which were subject to flooding.

Goz soils were studied at various places and the table below gives data for a deep profile in Fasher town exposed by a stream which runs seasonally into the fula or reservoir. The profile was reddish-yellow on top fading into yellow below. At least two feet have been removed by erosion from the top of the profile. At the base of the profile there is a five inch thick layer containing irregular iron concretions, which occur about the level of the bottom of the seasonal water course and are probably associated with it. There are other high exposures of goz profiles near El Fasher which do not show this concretionary layer.

TABLE 5.

Foot Step	S.G. %	C.S. %	F.S. %	Silt %	Clay %	Salts %	pH	P ₂ O ₅ Truog	N ppm	W-B C%
0 — 1'	0	62	31	1	6	.006	7.65	20	165	.026
1' — 2'	0	72	21	1	6	.006	7.15	20	140	.030
2' — 3'	0	71	22	1	6	.006	7.20	20	145	.024
3' — 4'	0	70	26	0	4	.013	7.65	20	155	.015
4' — 5'	0	74	20	1	5	.017	7.10	20	100	.013
5' — 6'	0	81	13	0	4	.016	6.60	20	120	.010
6' — 7'	0	68	26	1	5	.013	7.60	20	125	.010
7' — 8'	0	75	20	1	5	.010	7.05	20	114	.003
8' — 8½'	0	76	18	1	5	.010	6.95	20	235	.008
99" — 104"	12	55	28	1	4	.010	7.45	20	215	.010
104" — 110"	0	68	25	1	5	.009	7.25	20	145	.008

D. Upper Nile Province (Bor).

A group of samples were collected by the Pasture Research Officer from a number of riverside sites near Bor. They are alluvial grey-black soils similar to Juba samples from similar sites.

The mechanical analyses of the profiles show a range of 29—71 per cent clay in the surface soil. The change of texture down the profile varies from a steady increase to a steady decrease. None of the samples contains any stones and gravel fraction, and only small amounts of coarse sand are present.

All the soils are acid throughout their profiles, the pH of the surface soil varying between 4.40 and 6.50 with most of the values between 5.00 and 6.00. These soils are seasonally flooded. The water table is high during much of the season and the agricultural value of the soils is dominated by this factor. As would be expected with this seasonal flooding and high water table the nitrogen contents are high, ranging up to 3000 ppm in the surface layers.

The exchangeable calcium in the upper soil is in the range 5 to 10 mg.e. per 100 g. soil. Available phosphate by Truog's method is about 50 p.p.m. as P₂O₅.

The table below gives data for a fairly typical hole.

Bor B. The colour was described as black throughout the profile with iron staining at all depths. The water table was at $3\frac{1}{2}$ feet. The reason for the accumulation of nitrogen in the 3rd. foot is not known. Other profiles show less well marked accumulations and it seems possible that the presence of a high water table and the heavier texture is responsible.

TABLE 6.

(Bor).

S.G. %	C.S. %	F.S. %	Silt %	Clay %	Salts	pH	N ppm	Na value	Ca MgE/ 100g
o	o	39	10	52	109	5.29	1580	1	9.1
o	o	44	9	47	087	5.24	1610	1	9.0
o	o	52	8	39	076	5.51	1040	1	
o	o	55	9	36	072	5.38	860	2	
o	o	27	9	63	092	5.28	2570	2	
o	o	28	11	61	087	5.36	1240	1	
o	o	37	12	51	108	5.40	870	2	

The samples in the profile are arranged in successive 6" steps.

Walkley-Black organic carbon for the Bor profile are in agreement with the nitrogen values in shewing an accumulation zone in the lower layers. The figures in %C are :—

Bor : 2.48, 1.89, 1.13, 0.84, 1.13, 1.23, 1.04.

4. NITRATES IN PLOTS 10—15 (G.R.F.)

For 21 years the nitrates in the top foot of all the sub-plots of the 3—Course Rotation Experiment have been sampled monthly. The date of sampling has varied considerably over this period but the results do give a general picture of nitrate changes in all the phases of five three-course rotations.

The most striking thing about the results is the large fall in the level of nitrate nitrogen about the eighth year of the experiment. It is unlikely that this is due to changed technique in sampling or in determination of the nitrates. There are for example cotton phases of some rotations which have maintained their levels of nitrate nitrogen better than others, and in general the later values in no way bear any constant relationship to the earlier ones.

The mean levels of nitrate nitrogen in the cotton phase during the months of August, September, October and November,—the main period of vegetative growth of the cotton plant—and the mean values for the whole year are given below together with the corresponding average yields of the five rotations.

Rotation	August- November	Whole year	Yield k.p.f.
1 CFF	9.8 ppm.	8.7 ppm.	4.31
3 CDF	11.3 „	8.2 „	4.09
3 CDD	6.9 „	5.2 „	2.96
4 CLF	13.8 „	11.3 „	4.79
5 CDL	12.0 „	8.2 „	4.28

C = Cotton. F = Resting land. D = Sorghum (dura).
L = Dolichos lablab (lubia)

The mean nitrate figures for the year are in almost linear relationship to the yields. The August—November means are also nearly directly proportional to yields except for the rotation C-F-F.

There are well marked seasonal changes in nitrates ; these are illustrated below for the CDF rotation in parts per million of nitrate nitrogen.

Phase	May	J	J	A	S	O	N	D	J	F	M	A
Cotton	7.5	8.0	8.5	9.5	8.5	13.0	14.0	7.0	7.5	6.0	5.0	4.0
Dura	3.0	3.0	4.5	5.5	3.5	2.5	2.0	2.0	2.5	2.0	2.0	2.0
Fallow	2.5	2.0	4.0	6.0	5.0	7.0	7.0	8.5	7.0	7.5	7.5	7.5

There is strong evidence for a fall in nitrates towards the end of the rains, and this is at least partly due to washing down. The figures given later demonstrate this moving down of nitrate to lower levels during the rains. The levels of nitrate nitrogen in this table never attain the levels found in laboratory nitrification experiments conducted under favourable moisture and aeration conditions and in which there can be no leaching of nitrates. During the rains there is of course up-take of nitrates by weed growth and the incidence of this must vary widely from year to year.

There is a tendency for nitrates during the rains to be negatively correlated with the corresponding presowing rainfall. The correlation coefficient between the August nitrates in the cotton phase of CDF with the corresponding July—August 15th. rainfall is significant at the 0.05 level. Further work on these lines is planned.

The cotton phases of this experiment have been sampled very much more intensively than in the long-continued work described above.

The following table gives the averaged results in ppm NO_3 — N oven-dry soil for 6" steps.

TABLE 7.

Date	May 23rd				June 14th				July 21st				Aug. 14th				Sept. 19th			
Step	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Rotation																				
1	10	12	10	5	11	12	13	6	7	9	10	6	3	1	1	12	2	2	2	3
2	4	2	2	2	4	3	2	2	3	3	2	1	2	1	1	3	2	2	2	2
3	1	1	1	1	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1
4	18	14	11	6	17	19	11	7	11	13	10	7	9	3	5	12	7	3	3	7
5	3	5	3	2	3	3	3	2	5	5	3	3	5	2	3	7	2	3	3	4

There is, as there has been in the last two years, a fall in nitrate content in the 1st foot during the rains except in the CDD rotation. The contrast between the nitrate distribution in depth on May 23rd and Aug. 14th is striking and in agreement with the washing down effect noted above. It should be remembered that these plots are prewatered in the first half of August, so the rainfall is not the only washing down agent.

5. CARBON DIOXIDE FROM GEZIRA SOIL.

Carbon dioxide evolved from soil is collected in 0.1N sodium hydroxide in a closed flask and determined by back titration. The soils are first foot composites of the five different rotations of plots 10 and 11. They were all under cotton in 48/49. The samples were taken in August 1948 before sowing.

The evolutions of carbon dioxide are in the same order of rotations as those of last year, but are much smaller. Last year's samples were taken in May 1946. There are temperature differences between the two determinations, and the 1946 samples had been stored much longer than the present set.

The extent of the annual differences between CO₂ evolution has only so far been investigated in a comparison of first foot rotation I and II samples taken in August 1947 and August 1948. Again there is a difference in length of storage, but the determinations were made at constant temperature (30°C).

The samples of the two years showed no substantial difference in CO₂ evolution.

With rotation III 1948 samples, a comparison of August and May samples has been made at room temperature over a period of 11 days. The mean consumptions of 0.1N NaOH were 2.49 cc and 4.03 cc. respectively.

The CO₂ evolutions are small compared with most soils, in accordance with the known very low organic matter content of Gezira soil. The general level of Walkley-Black organic carbon is about 0.3 per cent. Addition of organic matter leads to a rapid increase in carbon dioxide evolution. The table below shows the extent of this increase with sucrose additions.

% age sucrose	0	0.25	0.125	0.062	0.031
Equivt. cc. 1N NaOH ..	4.9	19.0	12.3	7.3	5.5

The evolutions are for 112 hours and 50g of stored air-dry Gezira soil with addition of 40 per cent of water.

When cotton seeds are added to the soil in these experiments the evolution of CO_2 in germination is easily measurable. Thus 2 cotton seeds plus 50g soil in 150 hours gave CO_2 equivalent to 15.6 cc 0.1N NaOH at c. 50 per cent moisture. It is evident that the oxygen required for the early respiration of 2 germinating cotton seeds is of the same order as that required for microbiological respiration in 50g of moist soil. It appears that there may well be limiting competition for oxygen when cotton seed germinates in Gezira soil.

Experiments showed that small additions of organic matter delayed germination in its early stages. This we ascribe to increased competition for oxygen. The effect of organic matter additions is the more marked the higher the moisture contents, a circumstance which would reduce the rate of gaseous diffusion through the soil. If seeds are placed on the floor of a conical flask and covered with soil, the rate of extension of the roots is fairly easily measured. In one such experiment with 2 seeds in each flask the mean length of roots in untreated soil after 120 hours was 3.7" as against 2.0" in soil treated with 0.17 per cent of sucrose.

In practice about 10 seeds are sown per hole and there must be some competition for oxygen. In 200g. of soil with the addition of 45 per cent of water a comparison was made of the rates of growth of roots where 2, 4 and 6 seeds were sown per flask.

After 127 hours the mean length of the roots were :—

2 seeds per flask	7.0"
4 seeds „ „	5.8"
6 seeds „ „	5.0"

The CO_2 evolved was measured and the mean totals in cc 0.1N NaOH are given below for each flask.

2 seeds per flask	17.2 cc.
4 „ „ „	27.7 cc.
6 „ „ „	33.8 cc.

These show a progressive decrease in CO_2 per seed with increasing numbers of seeds. (Note the figures include the CO_2 from the soil itself).

The matter was further tested by varying the depth of soil above the germinating seeds. This was done in 600 cc conical flasks, 100, 200 and 400g of soil being used, with increased depth of soil and of course a corresponding restriction in its surface area. The flasks were duplicated and each had two seeds and 45 per cent of water was added. In one flask each, of those with 200g soil and 400g soil only one of the two

seeds germinated. At 140 hours the mean length of the roots of the germinated seeds was :—

100g of soil per flask	..	..	..	..	..	6.5"
200g „ „ „ „	..	..	..	..	..	6.6"
300g „ „ „ „	..	..	..	..	..	4.2"
400g „ „ „ „	..	..	..	..	..	2.1"

There is nothing in these results inconsistent with the hypothesis of competition for oxygen influencing early growth but there are other explanations. The above observations are confined to very young plants whose growth is probably not conditioned by nutrient uptake. A point of view which deserves investigation is whether the respiration which takes place in the soil during the rains and before sowing is sufficient to reduce, to an important degree, the competition of the micro-organisms for oxygen after sowing.

6. ORGANIC NITROGEN IN GEZIRA SOIL.

Table 8 gives the organic nitrogen values (p.p.m.) of first foot soil samples taken from the cotton plots in the 1946/47 and 1947/48 seasons.

TABLE 8.

	Plots 12 and 13 1946/47 Cotton Crop				Plots 14 and 15 1947/48 Cotton Crop.						
Rotation	Sampling Dates 8.5.46 15.5.47		Amt. fixed May to end of July	Fixtn. up to 15.5.47	Cotton Yields 1946/47 k.p.f.	Av. past 10 seasons k.p.f.	Sampling Dates Max. 28.5.47 Level 10.5.48 July 1947			Loss of N	Cotton yields 1947/48 k.p.f.
CDF	219	330	64	111	2.21	4.30	342	351	254	97	2.95
CDD	223	331	77	108	1.58	3.10	352	352	268	84	2.13
CLF	247	346	37	99	2.84	4.95	358	376	268	108	3.80
CFF	222	322	50	100	2.38	4.66	328	354	259	95	2.22
CDL	231	362	77	131	2.43	4.55	376	389	272	117	3.29

This table shows the remarkable difference in the variation in organic nitrogen during the two seasons. Briefly, in 1946/47 there were two periods of fixation. The first during the rains and the second between October and the middle of the following May. The average amount fixed during the year from May 1946 to May 1947 was over 100 ppm. which is approaching 50 per cent of the amount present in May 1946.

In May 1947 sampling of the next year's cotton phases started, the values being closely the same as the terminal values of the 1946/47 cotton phase. During the rains of 1947 little fixation was found and from the beginning of August to October a large loss of nitrogen occurred. This loss was increased during the period from October 1947 to May 1948. So over the two years a large increase was followed by a decrease of similar size.

Table 8 also shows that the relationship that existed between the amount of fixation and the cotton yield in the 1946-47 season also holds with 1947-48 season. The nitrogen loss of that period has been regarded as a negative gain and it is then found that highest yields are associated with the lowest fixation *i.e.* with greatest loss.

Table 9 shows the beginning and end of season organic nitrogen on the cotton plots over the two seasons so far studied.

TABLE 9.
Organic Nitrogen in ppm.
1st Foot.

	Plots 12 & 13 1946/47 cotton crop		Plots 14 & 15 1947/48 cotton Crop		Plots 10 & 11 1948/49 Crop
	8.5.46	15.5.47	28.5.47	10.5.48	8.5.48
CDF	.. 219	330	342	254	
CDD	.. 223	331	352	268	
CLF	.. 247	346	358	268	
CFF	.. 222	322	328	259	262
CDL	.. 231	362	376	272	

Work in conjunction with the 1948-49 crop has been carried out on the cotton-fallow rotation only. The top two feet of all phases have been sampled.

By and large the changes that have occurred approximate to those shown by all five cotton phases in the 1946-47 season. Appreciable fixation occurred during the rains. The closing stages of the 1948-49 season on this rotation are being studied in detail to see if the fixation which took place between October and May in 1946-47 will be repeated this year. The three rotational phases have had the same nitrogen content within close limits throughout the season. This is in contrast to the five separate rotations under cotton already mentioned, where differences in extent of fixation were established at certain critical times. Further, the first and second foot nitrogen values of the CFF rotation are very much the same.

7. FERTILITY OF YAMBIO SOILS.

An examination of samples from native cotton plots has been made to see if there is any obvious relation between profile characteristics and fertility. The fertility was estimated by measurements of the heights of the cotton plants. This is admittedly unsatisfactory but nothing better was possible. The soil profile in this part of the Sudan is extremely variable. Its most obvious feature is the frequent occurrence of layers of lateritic gravels which are also the most variable feature of the profile.

The gravel layer varies in position and density and, in this sampling programme, without apparent connection with topography.

Neither field observations nor laboratory data showed any feature very closely related to plant vigour. A certain number of correlations were worked out. The correlation coefficient between height of plant and pH. of surface six inches is 0.123 and has no significance. That between height and exchangeable calcium in the surface six inches is + 0.368, and is significant at the 0.02 level. The correlation coefficient between height and total nitrogen of the surface six inches is almost significant at the 0.02 level.

An account of this work has been published in Proc. C.A.B. Conf. Trop. and Subtrop. Soils 1948. The table which follows gives some data for two holes :—

TABLE 10.

HOLE 1.

6" Step.	1	2	3	4	5	6	7	8	
S & G	0	1	0	4	19	41	40	36	%
C.S.	9	13	12	11	12	8	10	12	%
F.S.	66	61	61	57	48	32	30	30	%
Silt*	4	4	6	7	3	4	4	2	%
Clay	21	22	22	20	18	14	17	20	%
pH	6.15	4.80	4.55	4.45	4.65	4.90	4.90	4.90	
Salts	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	%
P205	27	14	15	14	19	17	13	11	ppm
Exch. Ca	2.85	1.25	n.d.	n.d.	n.d.	n.d.	1.50	n.d.	me/100g.
Exch. K	0.05	0.03	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	m/100g.
N	650	250	373	205	180	325	370	225	ppm

HOLE 4.

6" Step.	1	2	3	4	5	6	7	8	
S & G	9	1	83	68	56	76	50	65	%
C.S.	48	57	10	18	26	12	19	14	%
F.S.	32	28	5	8	9	5	11	5	%
Silt	1	2	0	1	1	0	2	1	%
Clay	9	12	2	5	8	6	19	16	%
pH	6.30	5.75	5.83	5.55	5.30	5.00	5.15	5.05	
Salts	0.03	n.d.	0.03	0.03	0.06	0.03	0.02	0.03	%
P205	12	7	7	7	13	11	10	10	ppm
Exch. Ca	4.75	1.8	—	—	—	—	1.1	—	me/100g.
Exch. K	0.00	0.10	—	—	—	—	—	—	me/100g.
N	860	480	260	230	300	285	370	310	ppm

8. DETERMINATION OF ORGANIC MATTER.

Two disadvantages were noted in the Walkley-Black titration procedure. Firstly the end point was somewhat troublesome. Secondly, a confirmatory titration was impossible, without weighing out a second soil portion. Both these flaws were eliminated by diluting to definite volume at room temperature, filtering, taking an aliquot and titrating with 0.1 N FeSO_4 . This also results in a saving of reagents.

With the method in this form determinations were carried out on pure sucrose solutions and on pure solid cellulose to test its duplicatability on organic matter of known purity and composition. Variations among duplicate titrations were in neither case appreciably greater than 1%. Since this is considerably less than the possible soil sampling error, the method thus far was considered to be satisfactory. The following empirical figure was deduced from the results : 1 ml. N $\text{K}_2\text{Cr}_2\text{O}_7$ solution = 3.0 mg. organic C. It now remained to test its duplicatability on soils before accepting it as a tested analytical method.

Accordingly the organic carbon in a large well mixed sample of surface Gezira soil was estimated. Twelve determinations were made and gave the figure 0.243 per cent with a standard deviation of 1 per cent.

It should be noted that no attempt has been made to allow for partial recovery of organic carbon in the calculations of the above results. The determinations have been referred to as " Organic Carbon, Walkley & Black Values " as suggested by Piper.

9. PRESOWING IRRIGATION.

Using a small pump a nominal 160 mms. of water were applied to the land during the period 14.7.48 to 4.8.48. The water was applied in small doses.

37½ mm in 6 applications	..	..	..	14.7 — 20.7
46 mm in 5 „	..	..	..	21.7 — 28.7
75 mm in 5 „	..	..	..	31.7 — 4.8

The water applied was measured, but there was some loss by wind blowing and the figures must be in slight error. The water was applied through a small nozzle, the jet being broken up by waving it gently over the plot section by section. The resulting fall gave only an inferior imitation of genuine Gezira rainfall. During the period of application 151 mm of rain fell.

The yields were, sprayed 5.32 k.p.f. and 5.53 unsprayed, very closely the same for treated and untreated plots. This result and that of last year's small applications of water in the furrows are evidence that either only presowing rain affects the crop, or that small applications at a time are ineffective.

On a main-crop plot an unpremeditated fairly heavy prewatering was given to randomised angias between 18.7 and 23.7.48, which was a rainless spell.

The prewatering amounted to a heavy normal watering. A great deal of the water was applied to the lower layers of soil by way of the deep cracks. Rain following this watering stood about considerably longer on the watered areas than on the controls. In September improved growth was noticeable on the watered angias, but in November this improvement was no longer observable. The final yields were closely the same on treated and untreated replicates, but there was a marked change in the rates of picking. The prewatered treatments gave 42 per cent of their total seed-cotton in the first two picks and the controls 33 per cent.

10. ANALYSIS OF COTTON LEAVES.

This investigation was carried out in collaboration with the Plant Physiology Section who did the sampling.

The cotton plants of the five Three-Course Rotations on Plots 10 and 11 were sampled on 16.9.48. The following table gives the oven dry weights of the leaf samples, and the percentages of nitrogen, P_2O_5 , K_2O and CaO for each rotation O.D. basis.

TABLE II.

Rotation	Weight of Sample	Yield	%N	% K_2O	% P_2O_5	% CaO
1 CFF	6.1 g	3.91 kpf	3.12	2.79	0.73	5.60
2 CDF	6.0	2.89	3.34	2.74	0.89	5.14
3 CDD	7.7	2.67	3.65	3.03	1.02	5.08
4 CLF	8.9	4.28	4.09	2.98	0.96	5.69
5 CDL	11.4	4.04	4.24	3.15	0.85	5.76

11. RAIN DURA LANDS.

A. Kassala Province.

On the Mechanised Crop Production Scheme at Ghadambaliya a series of samples was taken for moisture determinations. In Table 12 are given the moisture contents of two plots at various dates, the one first year cultivation and the other in its third successive year of cultivation. Field staff formed the strong impression that there was better moisture penetration on the virgin land. This is not borne out by our determinations. The plots though adjacent were not part of one experiment and there may have been some differential rainfall, but none the less it is very difficult to see how these figures can be in substantial error. At the close of the season, and into the hot weather of 1949 the continuous cultivation plot showed higher moistures from 6" to 36". The plots grew different varieties of Sorghum and so the effect may be due to cropping differences but it may also be indicative of a real difference in moisture holding ability against air drying. If this is so it would most probably be paralleled by an increased capacity to resist moisture extraction by roots.

As with similar results last year there is every indication that the early rains do not penetrate far down the cracks. It also appears that little water is stored at any period in the 4th. foot of soil.

TABLE 12.
PERCENTAGE OF WATER ON OVEN DRY BASIS.
VIRGIN LAND.

Date	0—6"	6"—12"	12"—24"	24"—36"	36"—48"	Virg. land
21. 9	35	35	27	22	23½	
5. 10	30	33	29½	25	24½	
14. 11	16	23	23	24	25	
12. 12	11	19	21	23	25½	
9. 1	11	18	20½	22	26	

3RD YEAR OF CULTIVATION.

21. 9	36	35½	35	30	24	
5. 10	33	33½	31	26	24	
14. 11	19	25	26	26	25	
12. 12	12	22	24	24	25	
9. 1	10	19	21	23	24	

The rainfall up to 21.9.48 was 437 mm and 484 mm up to 9.1.49.

Expt. 2., Camp 11 was fallow disced in 1947 and sown with Sorghum in 1948 with no hand weeding after sowing. Expt. 3A Camp 11 was twice fallow disced in 1947 and again 3 times in 1948 and then remained unsown.

The moisture contents at 24.4.49 were as follows :—

	0—6"	6"—12"	12"—24"	24"—36"	36"—48"	
Expt. 3A	6½	21	28	29	29	%
Expt. 2	6	12½	18	21	25	

The figures for the cropped land are similar to those for the areas given above. The land thrice cultivated has high moistures, which should persist into next sowing season.

B. *Kordofan Province.*

The results of moisture sampling of cotton plots last year at the Khor Abu Habil Scheme showed that at the end of the growing season big differences in subsoil moisture existed in adjacent areas. This year a differential irrigation experiment was performed in which, during August, land was flooded for varying periods up to 30 days. Moisture contents were taken at the end of this treatment and again at the end of the growing season.

TABLE 13.

Sampling Date	Time flooded	Percentage water on oven dry soil					
		Depth of samples in Feet					
		1	2	3	4	5	6
2nd. & 3rd September	5 days	39	39	23	15		
	10 "	40	39	31	23		
	15 "	41	41	37	23		
	20 "	42	44	36	25		
	25 "	43	41	36	31	26	18
23rd & 25th. December	5 days	18	21	16	14		
	10 "	17	20	18	16		
	15 "	18	22	22	22		
	20 "	18	21	18	17		
	25 "	21	24	22	22	22	18

EXPERIMENTS IN CENTRAL RAINLANDS

I. Mechanised Crop Production Scheme

Ghadambaliya (Kassala Province)

by

T. R. G. Moir.

The scheme at Ghadambaliya (lat. 14°01' N, long. 34°59' E) was begun in 1945 to investigate the possibilities of mechanised crop production in the clay plains of the central rainlands.

The area lies in the 400—500 mm. rainfall belt. In 1948 rainfall on the Scheme was well above average and varied from 456 to 733 mms in different parts of the scheme, the eastern side receiving more than the western. The rains started very early with heavy falls of rain in the last 10 days of May; this was accompanied by a sharp drop in evaporation and saturation deficit and also in maximum temperatures. These remained low, except for an increase in the first part of July, until the end of the rains. Rainfall during June and the first 20 days of July was low and it was not till the 18th July that a sufficiently heavy fall of rain occurred on the experiment farm to enable sowing to be carried out; it was not therefore possible to arrange for any very early sowing dates.

On the whole the 1948 season may be regarded as a favourable one with well distributed rainfall except for two dry spells during the sowing season in August and September. Unfortunately the season was also favourable for insect pests and there was heavy damage of crops by grasshoppers.

EXPERIMENTAL AREAS

The main experimental area was on land which had been cultivated under dura in 1946 and 1947 and was thus being sown for the third successive year. There was some evidence in this area of loss of tilth in the surface soil and following the heavier rain storms there was considerable local soil wash, small seedlings frequently being found buried by washed soil; absorption of water was also slower than on adjacent virgin land and the surface took longer to dry out. Soil wash was undoubtedly increased by the numerous tractor and car tracks in the area. Nevertheless heavy yields were obtained from some of the dura sown in this area during July. Since 1946 this area had the following treatments, 1946 disced twice; 1947 disced twice; 1948 disced once, cultivated once.

A large proportion of the experimental work with dura in 1948 consisted of a programme drawn up by Mr. Clouston for execution by the M.C.P. Scheme. This included a large scale spacing experiment covering 90 feddans laid out on virgin land on the west of the Ghadambaliya to Camp 1 road and a large scale fallow discing experiment in the same area. An experiment giving a comparison of dura and sunflower on virgin and fallow disced land was sown in the Camp 11 area.

Weed growth on the land cultivated during 1946 and 1947 was very light and consisted mostly of *tabr* (*Ipomaea cordofana*) which had germinated during the May rains. The single disc harrow used in this area was not very effective in killing this weed and even the ducks-foot cultivator missed a good many ; on fallow plots and roads which received no hand weeding the *tabr* formed big mats by the end of the season. On the virgin land grass continued to germinate until the middle of August ; heavy hand weeding was necessary.

DURA

I. VARIETY-SPACING EXPERIMENT.

(a) Design of Experiment.

A split plot experiment designed by Mr. Clouston embodying 5 varieties, 3 inter-row spacings and 5 within-row spacings.

Treatments were as follows :—

Inter-row spacings.

36 inches between rows.

42 inches between rows.

60 inches between rows.

Within-row spacings.

Varieties.

3 plants per metre	..	..	Feterita Suki	(F.S)
5 plants per metre	..	..	Feterita Maatuk	(F.M)
7 plants per metre	..	..	Mugud Ahmer	(M)
9 plants per metre	..	..	Wad Akr Abiad	(A)
11 plants per metre	..	..	Westland Combine	(C)

Layout. Three blocks.

The experiment was repeated at two sowing dates.

Area of plots (before discards were cut out).

Inter-row plot	..	5 feddans	(4.375 feddans after discards)
Within-row plots	..	3 feddans	(2.625 feddans after discards)
Variety plots	..	1 feddan	(0.875 feddan after discards)
Sub-plots	..	1/5 feddan	(0.175 feddan after discards)
Blocks	..	15 feddans	(13.125 feddans after discards)

(b) Site of Experiment.

The experiment was situated on virgin land to the north of Ghadabaliya on the west side of the Ghadambaliya to Camp 1 road.

The land proved to be rather uneven and the top end Block 1 of the first sowing date was covered by standing water for several days before sowing. Variations in yield due to uneven distribution of soil moisture were very much greater than those due to treatments and seriously decreased the precision of the experiment.

(c) *First Sowing date.* Sown 14/8 to 17/8

Disced twice 22/6—24/6. Cultivated 16/7—18/7. Sown 25/7 to 26/7. Establishment was poor owing largely to loss of stand due to "Camp 8 disease" (see p. 52).

Whole area cultivated and rod-weeded 11/8.

Resown 14/8 to 17/8. Resowing gaps by hand 25/8—29/8.

Hand weeded 8/9, 8/10. Thinned 11/9—17/9.

Harvested 19/11, except Mugud 30/11.

The crop suffered from a fairly severe grasshopper attack in October and November, the Wad Akr variety being particularly severely damaged; leaves were stripped and unripe grain eaten in the head. A visual estimate of grasshopper damage was made on each plot and by examination of yield figures an estimate of reduction in yield caused was obtained.

Grasshopper damage. Estimate of loss of yield.

Variety	Inter-row spacing.		
	36"	42"	60"
Feterita Suki	17.0%	13.9%	5.2%
Feterita Maatuk	22.2%	12.6%	5.2%
Mugud Ahmer	3.9%	2.6%	3.0%
Wad Akr Abiad	45.2%	36.1%	18.7%
Westland Combine	15.7%	14.8%	7.8%

Different within-row spacings had little differential effect on damage.

In general plots which were showing signs of drying off and wilting suffered the heaviest damage while those that remained green largely escaped. Damage is lighter at the 60 inch spacing than at 42 or 36 inches. Wad Akr is particularly susceptible to damage while Mugud is little attacked.

Yields. Rotls per feddan.

Inter-row spacings—mean yields over all varieties and all within-row spacings.

36 inches	649.9
42 inches	740.5
60 inches	991.9

Differences are not statistically significant.

Within-row spacings. Mean yields over all varieties and inter-row spacings.

3 plants/metre	..	..	..	773.3
5 plants/metre	..	..	..	813.3
7 plants/metre	..	..	..	668.2
9 plants/metre	..	..	..	854.1
11 plants/metre	..	..	..	861.7

Differences are not statistically significant.

Varieties. Mean yields over all inter-row and within-row spacings

Feterita Suki	..	..	..	921.5
Feterita Maatuk	..	..	..	897.0
Mugud	..	..	..	624.3
Wad Akr Abiad	..	..	..	808.0
Westland Combine	..	..	..	719.5

Feterita Suki gives the highest yield and significantly outyields Mugud, Akr and Combine ; Maatuk significantly outyields Mugud and Combine. The significant difference between variety means is 111.0 rotls per feddan for $P = .01$.

The interaction between within-row and inter-row spacings is significant where $P = .01$. Inspection of the yield table (not included here) shows that the following differences are significant.

At 36" spacing. 9 plants per metre and 11 plants per metre out-yield 5 plants per metre.

At 40" spacing 5 and 9 plants per metre outyield 7 plants per metre.

At 60" spacing no differences are significant.

The 60" spacing outyields the 36" spacing for within-row spacings of 3, 5 and 7 plants per metre.

The 60" spacing outyields the 42" spacing for within-row spacings of 3, 7 and 11 plants per metre.

The 42" spacing outyields the 36" spacing at 5 plants per metre, all other differences being insignificant.

Feterita Suki and Feterita Maatuk gave the best yields. Mugud did badly and the yield from the combine variety was also rather poor. Wad Akr suffered very heavily from grasshoppers as compared with other varieties and yield is correspondingly rather poor.

Differences in thinning rates between 3 and 11 plants per metre apparently have little effect on yield. This is probably due to the fact that the original stand was thin and, during thinning, the plants removed would be mostly those which grew from the hand resowings which were 10 days later than the original sown plants and often failed to produce any heads. Differences between the within-row spacings were also masked by flood water in Block 1, which was distributed mostly on the 9 and 11 plants per metre spacing and which caused enormous yield differences. Three replications were anyhow inadequate. The much higher yield of the 60 inch inter-row spacing as compared with the 36

and 42 inch spacings is probably a real one ; replications were however quite inadequate and the difference was increased by the lower grasshopper damage on the 60 inch spacing.

(d) *Second Sowing date.* Sown 11/9 to 12/9.

At this sowing date dead grass was not burnt off before discing. The plots were disced three times before sowing, on 24/6, 23/7 and 17/8 and hand weeded on 24/9. Thinning was carried out on 6/10. Harvesting began on 5/12. Establishment was again poor and heavy resowings were made by hand on 21/9 and 23/9. Final stand was poor on many plots especially for Mugud. Damage by grasshoppers was light except for Wad Akr in Block 1 where some plots showed up to an estimated 20 per cent loss in yield.

Yields. Rotls per feddan.

Inter-row spacings. Mean yields over all varieties and all within-row spacings.

36 inches	818
42 inches	1000
60 inches	768

Differences are not statistically significant.

Within-row spacing. Mean yields over all varieties and all inter-row spacings.

3 plants/metre	825
5 plants/metre	997
7 plants/metre	813
9 plants/metre	810
11 plants/metre	864

Differences are not statistically significant.

Varieties. Mean yields over all inter-row and within-row spacings.

Feterita Suki	742
Feterita Maatuk	1038
Mugud Ahmer	935
Wad Akr Abiad	834
Westland Combine	760

Differences are significant for $P = .01$, when the difference between yields is 66.5 rotls.

Feterita Maatuk significantly outyields all other varieties. Mugud outyields Akr, Suki and Combine ; Akr outyields Suki and Combine ; other differences are not significant.

The interaction between variety and within-row spacing is just significant for $P = .05$. Inspection of the yield tables (not included here) shows that irrespective of inter-row spacing, Feterita Maatuk is best at 5 plants per metre spacing, and significantly outyielded 9 plants

per metre spacing. Mugud is best at 5 plants per metre spacing and significantly outyields 7 and 9 plants per metre spacing. For Akr the 5 plant per metre spacing significantly outyields all other spacings. For Feterita Suki and Combine the 11 plants per metre spacing is best but differences are not significant.

The interaction between inter-row and within-row spacing just misses significance for $P = .05$; the 5 plant per metre spacing is best at all inter-row spacings. The 42 inch spacing is better than 36 or 60 inch spacings, except at 5 plants per metre where the 36 inch spacing is best.

(e) Conclusions.

Sowing date.

The yield of the second sowing date over all treatments is higher than that of the first sowing date. There is however only 8 rotls per feddan difference between the best inter-row spacing at the first sowing date and the best spacing at the second sowing date. The first sowing date suffered very much more severely from grasshopper attack than did the second.

Inter-row spacing.

The 60 inch spacing gave the best yield at the first sowing date, the 42 inch spacing gave the best yield at the second; yield differences although considerable were not significant and may be merely accidental. At the first sowing date the 60 inch spacing suffered least damage from grasshoppers.

Within-row spacing.

Remarkably little difference has shown up between different treatments; this is probably partly due to poor initial stands, the resowings being much later than the initially sown plants and often failing to compete. Tillering is undoubtedly suppressed by close spacing of plants within the row and a count of the number of heads per 10 metres of row showed only small differences.

Varieties.

Feterita Suki was best at the first sowing date but was worst at the second sowing date. Feterita Maatuk was outstanding at the second sowing date and was second at the first sowing date. Mugud Ahmer did very badly at the first sowing date but was second at the second sowing date. Wad Akr gave fair yields at both sowing dates but suffered severely from grasshopper damage. The Combine variety Westland gave poor yields at both sowing dates.

II. VARIETY TRIAL A.

Sown on land cultivated for the third year. A replicated trial of the same varieties as in the previous experiment but all sown in rows 42 inches apart and thinned to 3 plants per metre.

(a) *First Sowing date.* Sown 25/7.

Disced 14/7; cultivated 24/7. Thinned 25/8. Harvest started on 2/11. Size of plots = $\frac{1}{2}$ feddan, 4 replicates. Germination was good on all plots; there was some loss of plants due to "Camp 8 disease" but a full stand was obtained.

Yields—Rotls per feddan.

Feterita Suki	..	..	..	..	1295
Feterita Maatuk	..	..	..	..	1395
Mugud Ahmer	..	..	..	..	1241
Wad Akr Abiad	..	..	..	..	1342
Westland Combine	..	..	..	..	822

Significant difference between means for $P = .01$ is 369 rotls.

The Combine variety gives a significantly lower yield than all other varieties; other differences are insignificant.

(b) *Second sowing date.* Sown 28/8.

Disced 14/7. Cultivated 24/7. Thinned 2/10.

Harvest started on 15/12.

Germination was rather poor and the stand obtained was very patchy.

Yields—Rotls per feddan.

Feterita Suki	..	..	..	..	612
Feterita Maatuk	..	..	..	..	618
Mugud Ahmer	..	..	..	..	742
Wad Akr Abiad	..	..	..	..	644
Westland Combine	..	..	..	..	352

The significant difference between means for $P = .01$ is 240 rotls.

The Combine variety gives a significantly lower yield than all other varieties; other differences are not significant.

(c) *Conclusions.*

As compared with the previous experiment on virgin land it will be seen that in this experiment the first sowing date gives very much higher yields than the later sowing date; the reverse was the case in virgin land. The difference in behaviour is presumably tied up with differences in soil structure. From practical experience it can be confidently asserted that moisture penetration is more rapid and extends to a greater depth in virgin land as compared with *komodob*. This has not however been borne out up to date by soil moisture analyses. Analyses of soil nitrates on a *komodob* and virgin land plot showed marked differences between the two. In the *komodob* plots soil nitrates were high in July and then rapidly dropped off up till the end of the rains; on virgin land soil nitrates were relatively low at the beginning of the rains but increased markedly towards the end of September. Available

nitrogen is particularly important to crops during the early stages of growth and this may explain the better yields from late sowing on virgin land.

The Combine variety Westland clearly has not got a yield capacity anything like as high as the local varieties. The variety Mugud which did relatively poorly at the first sowing date did relatively well at the second as in the previous experiment. This bears out the contention of the cultivators that Mugud is a variety for late sowing.

Wad Akr Abiad did well in this experiment which suffered little damage from grasshoppers.

III. VARIETY TRIAL B.

A hand sown experiment including 24 varieties sown at 2 sowing dates on the main experiment farm (3rd year of cultivation).

Size of plot = 1/10 feddan. 5 replications.

First sowing date 19/7. Second sowing date 20/8.

Spacing. Holes 90 x 90 cms.

Yields. Rotls per feddan.

Variety	First Sowing Date.	Second Sowing Date.	Remarks.
Cap Rock	416	356	Double dwarf, red seeded.
Westland	598	284	Double dwarf, red seeded.
Midland	530	248	Double dwarf, red seeded.
Martin	580	248	Double dwarf, red seeded.
Plainsman	494	320	Double dwarf, red seeded.
Day Milo	680	444	Double dwarf, red seeded.
Queensland Milo	518	400	Double dwarf, red seeded.
Queensland Kalo	630	552	Double dwarf, red seeded.
Colby	574	466	Double dwarf, red seeded.
Cody	756	332	Semi-dwarf, white seeded.
Sooner Milo	698	484	Semi-dwarf, lodges badly.
Club Kaffir	696	398	Semi-dwarf, white seeded.
Queensland Hegiri	778	612	} Semi-dwarf, these varieties are identical.
Dwarf Hegiri	668	688	
Feterita Managil	754	632	Dwarf, heavy tillering.
Feterita Butana	712	698	Intermediate.
Feterita Maatuk	1064	738	Intermediate.
Feterita Suki	816	658	Tall.
Mugud Abiad	812	566	Tall, white seeded.
Mugud Ahmer	834	672	Tall, red seeded.
Hemeisi Butana	336	530	Like Mugud Ahmer.
Wad Fahl	578	542	Large heads, white seeded.
Wad Akr Ahmer	754	740	Semi-dwarf, brown seeded.
Wad Akr Abiad	714	598	Semi-dwarf, white seeded.

The significant difference between variety means is 215 and 285 rotls per feddan for $P = .05$ for 1st and 2nd sowing dates respectively.

Conclusions.

Considerable difficulty was encountered in getting the crop established owing to " Camp 8 disease " from which all varieties suffered and the stand was rather patchy especially with the combine varieties at the second sowing date. Nevertheless the results clearly show the superiority of the local varieties with Feterita Maatuk outstanding. The yields from the double dwarf varieties are poor. These varieties in spite of their small size are not very early maturing and seem to require a lot of water ; the root system is probably less well developed and efficient than that of the local varieties ; in fact a double dwarf variety probably has a double dwarf root system. The semi-dwarf varieties gave better yields and Cody and Club Kaffir are attractive varieties with high quality grain. The two Hegiri varieties are identical and should be suitable for combining. Mugud Abiad is very similar in growth to Mugud Ahmer ; it is said to require more water although differences in yield were not significant ; the grain fetches a rather higher price than that of Mugud Ahmer. Wad Fahl and Hemeisi Butana are both too slow maturing and require too much water for conditions on the M.C.P. Scheme.

In 1 feddan observation plots the local varieties Feterita Maatuk and Feterita Managil again outyielded introduced combine varieties sown at the same sowing dates.

IV. FALLOW DISCED EXPERIMENTS.

Experiment 1.

A hand sown experiment with 4 replicates but unrandomised. Sown 26/7.

The dura on virgin land grew away better to start with and the stand was good.

On fallow disced* land the stand was patchy and growth was later. Virgin land was harvested on 10/11 and the fallow disced plots which carried on growth later were harvested on 5/12.

Variety—Feterita Suki.

Yields. Rotls per feddan.

Fallow disced plots	..	..	..	1026
Virgin land plots	..	..	..	769

* Land which had been disced during the rains of the previous year, but not sown.

Experiment 2.

A large scale experiment designed by Mr. Clouston comparing *dura* and sunflower on virgin and fallow disced land. The experiment was replicated but not randomised. On these treatments was superimposed a randomised experiment involving 7 different pre-sowing cultivation treatments, half plots of which received post-sowing hand weeding the other half being left unweeded. The cultivation treatments which were carried out with the obsolescent tandem disc harrow are not considered here.

Variety. Mugud Ahmer.

Sown 27/7. Weeding 4/8, 6/9. Thinning 27/8.

On fallow disced land germination was somewhat uneven but further growth was good and healthy.

On virgin land where the old grass had been burnt off early growth was as good as on fallow disced land and the stand was good. On patches where the old grass had not been burnt and was disced in before sowing the stand both of *dura* and sunflower was poor; growth of both was also very poor in the early stages, the plants appearing to be suffering from nitrogen deficiency; root development was poor and the *dura* suffered from a heavy attack of leaf spot (*Colletotrichum graminicolum*). The difference between burnt and unburnt patches was clear cut and most striking in the early stages of growth but became less marked as the season progressed. By the time the crop came into flower the growth on the fallow disced plots looked markedly better than on the virgin land.

Yields. Rotls per feddan.

			Hand weeded	No hand weeding
Fallow disced plots	..	..	1908	250
Virgin land plots	..	..	506	11

The virgin land plots were no doubt affected by the heavy new germination of *anis* grass after sowing, the weed growth being heavier than on the fallow disced land and of a type that competes more severely than the dicotyledonous weeds on fallow disced land.

Conclusions.

Fallow discing causes a marked increase of yield of *dura* as compared with virgin land sown at the same date. The differences would probably have been much smaller had the virgin land plots not been sown until the middle of August. Anyhow the comparison really needed is one between fallow disced land and *komodob*. The yields of the fallow disced land do not compare particularly favourably with yields from *komodob* sown at the same date (see the preceding experiments) or with late sown virgin land.

Dura is evidently better able to compete with the weeds of *komodob* than with those of virgin land (grass).

V. MANURING EXPERIMENT.

A split plot experiment on 3rd year cultivated land to assess the effect of manuring with nitrogen, phosphate and potash fertilizers alone and in combination. Fertilisers were distributed on the plots after sowing in lines parallel with the rows and a few inches away.

Treatment.

N. = Ammonium nitrate at 100 rotls per feddan.

P. = Superphosphate at 200 rotls per feddan.

K. = Sulphate of potash at 100 rotls per feddan.

Variety. Feterita Maatuk.

Size of plot = 540 sq. metres. Replications 6.

Cultivated 29/7. Sown 11/8. Resown 4/9.

Thinned 18/9.

Germination was good but all plots suffered very severely from "Camp 8 disease" and the stand became very thin. Local surface soil wash was considerable, many seedlings being found buried. Heavy hand resowing was necessary but a good stand was eventually obtained although the crop presented a rather ragged aspect. No visual differences were noticed between plots throughout the season.

Nitrogen gave an increase in yield of 4 percent, but this was not significant, nor were other differences which were slight, nor interactions.

VI. WATERING AND NITROGEN MANURING EXPERIMENT.

A split plot experiment on a small area of virgin land near the *hafir* comparing the effect of giving 3 artificial waterings after the end of the rains with unwatered plots. Half plots were treated with ammonium nitrate at the rate of 160 rotls per feddan. Area was hand cleared on 28/7; cultivated 2/8, sown 7/8. Fertilisers distributed 12/8.

Variety. Feterita Suki. Plots after discards 1/50 feddan.

4 replications.

Waterings were given on 18/10—20/10, 1/11—2/11, and 15/11—16/11.

Each watering was estimated as being equivalent to about 50 millimetres of rainfall.

Germination was good and a good stand was obtained after light resowing; no "Camp 8 disease" was noticed. Growth of both watered and unwatered plots was good; the watered plots suffered from a very heavy attack of aphids in November.

Yields—Rotls per feddan.

		Nitrogen	No Nitrogen	Mean
Water	.. ..	1712	1537	1625
No water	.. ..	1050	1050	1050
Mean	.. ..	1381	1294	1338

The application of water significantly increased the yield by 55 per cent.

On the watered plots nitrogen manuring gave an increased yield of 11 percent but the difference is not significant. The highest single plot yields were equivalent to 2000 and 2050 rotls per feddan respectively ; both were water plus nitrogen plots.

Conclusions.

The experiment clearly demonstrates that in this area water is the limiting factor in dura yield. Additional nitrogen does not give any appreciable increase in yield even where additional water is given. The figure of 2000 rotls per feddan may be taken as an indication of the ceiling yield of dura on the M.C.P. Scheme.

SUNFLOWER

I. VARIETY—SPACING EXPERIMENT. 2 Sowing Dates.

Varieties.

Original black seeded.

Mars.

Southern Cross.

Pole Star.

Jupiter.

Spacing.

Rows sown 42 inches apart by drill and thinned as follows :—

2 plants per metre.

4 plants per metre.

6 plants per metre.

Size of plot = 1/10 feddan after outer rows had been discarded. There were five replications, the variety and spacing treatments being randomised independently in a split plot experiment. The experiment was on land being cultivated for the third consecutive year.

(a) *First sowing date. Sown 21/7.*

Plots disced 12/7. Resowing gaps 9/8. Thinned 19/8. Hand weeded on 22/7 and 22/9. Harvested 28/10. Germination was good but the stand was uneven and some resowing was necessary to get a full stand.

Growth was excellent throughout the season but by the end of September the soil was cracking out badly although the cracks were again partially closed by the rainstorm on September 30th.

Seedlings suffered fairly heavily from grasshopper attack to the leaves and considerable damage was done to ripening heads by the grasshopper *Catantops* which eats away the whole of the back of the heads although not apparently affecting the percentage of full seeds; it is difficult to assess the loss in yield that resulted. (see p. 117).

Jassids were reported by Mr. Joyce as causing severe leaf scorch during October. Two types of head caterpillar were also seen but these caused little damage.

Yields. Expressed in rotls per feddan.

Varieties	SPACINGS			Means
	2 plants/ metre	4 plants/ metre	6 plants/ metre	
Original Black ..	290	282	232	268
Mars	304	308	356	323
Southern Cross ..	292	318	286	299
Pole Star	244	328	346	306
Jupiter	288	328	318	311
Means	284	313	308	

Differences between variety means and between spacing means are insignificant. The variety spacing interaction is however significant for $P = .01$, the difference for significance between variety means at different spacings being 54.7 rotls per feddan.

For the Original Black variety the widest spacing is best, the yield at 2 plants/metre significantly exceeding that at 6 plants/metre. The highest yields were obtained from the varieties Mars and Pole Star at 6 plants/metre; the yield at this spacing significantly exceeds that at 2 plants per metre. For Southern Cross and Jupiter the 4 plants per metre spacing is best but yield differences are not significant.

(b) *Second sowing date. Sown 19/8.*

Disced 12/7. Hand weeded 15/8. Thinned 11/9 to 13/9. Harvested 22/11.

Other details as for first sowing date.

Yields. Expressed in rotls per feddan.

Varieties	SPACINGS.			Means
	2 plants/ metre	4 plants/ metre	6 plants/ metre	
Original Black ..	102	82	34	73
Mars	162	104	78	115
Southern Cross ..	150	102	76	109
Pole Star	156	120	92	123
Jupiter	188	144	110	147
Means	152	110	78	

The variety Jupiter significantly outyields all other varieties and Original Black gives a significantly lower yield than all other varieties, the significant difference between variety means being 19.2 rotls for $P = .05$. Varietal differences were probably affected by the distribution of the plots in the blocks. The outer plots of each block showed a marked marginal effect at this sowing date and the single discard row was insufficient to eliminate this. Jupiter occurred 4 times out of 5 in outer plots, no other variety occurred more than twice.

The 2 plants/metre spacing significantly outyields both the 4 & 6 plants/metre spacing, the significant difference between spacing means being 21.4 rotls for $P = .01$.

(c) *Conclusions.*

Rainfall and the length of the rainy season at Ghadambaliya are insufficient to give an economic yield of sunflower seed. Examination of the heads showed that between 40 per cent and 60 per cent of the seeds were empty at the first sowing date and even more at the second sowing date; this is ascribed to lack of water during the flowering and ripening period; isolated plants on roads and self sown plants which had germinated with the first rains had a very much higher proportion of filled seeds; 5 heads from self sown plants collected at the old experimental plot at Doka yielded nearly 1 rotl of seed. Economic yields can only be hoped for in the central rainlands where the crop can be sown in June and harvested before the end of September.

Mars and Jupiter seem the best of the semi-dwarf introduced varieties all of which give a better yield than the Original black-seeded variety from Equatoria.

With 42 inch rows a spacing of 4 plants per metre would seem about right for the semi-dwarf varieties when sown early. A wider spacing between rows might however be desirable.

II. FALLOW DISCED EXPERIMENTS.

Experiment 1.

A replicated but unrandomised experiment comparing yields on fallow disced and virgin land at Camp II.

Plots 0.31 feddan sown by hand on 26/7. 4 replicates.

Variety. Diamond selected.

Yields.				Rotls per feddan.
Fallow disced plots	..	..	..	344
Virgin land plots	..	..	..	186

Experiment 2.

A large scale replicated but unrandomised experiment comparing the growth of dura and sunflower on virgin and fallow disced land. On this was superimposed seven different cultivation treatments but as these were for testing out the work of the obsolescent tandem disc harrows the effects are being disregarded.

Size of plots $\frac{1}{4}$ feddan. Replications 28.

Sown by drill on 27/7 to 28/7. Thinned to 2 plants/metre.

Harvested 3/11 to 5/11.

Variety. Original black seeded.

Yields				Rotls per feddan.	
				Hand Weeded	No hand weeding
Fallow disced	..	..	..	282	160
Virgin land	..	..	..	188	23

Conclusions.

The yield of sunflower on fallow disced land is considerably higher than on virgin land and compares with yields on the 2nd year *komodob* at Ghadambaliya. Sunflower competes well with the weeds of fallow disced land (mostly *tabr*) but is unable to compete with *anis* grass. Fallow discing does not increase yield of sunflower sufficiently to make it economic.

SAFFLOWER

SPACING TRIAL.

Treatments.

Plots were sown by drill in rows 36 inches apart and thinned to 4, 8 and 12 plants per metre.

The crop was sown on 27th July using Gear 3 of the Massey drill and the left hand side of the feeder wheel. Date thinned 5/8. Harvested 30/10. Variety Shambat. Size of plot after cutting out discards = 0.08 feddan.

Germination was excellent and an even stand was obtained. The crop grew away well but suffered severely in September and early October from the attacks of a caterpillar similar to but larger than American bollworm. The upper leaves and bracts were stripped and the heads were also attacked. Loss of crop by damage to the heads alone was at least 15 per cent.

Yields.			Rotls per feddan	
4 plants/metre	..	..	..	302.5
8 plants/metre	..	..	..	340
12 plants/metre	..	..	..	360

The closest spacing gives the highest yield but yield differences are not significant.

From observation of the crop during growth it appeared that a closer inter-row spacing might give higher yields but it was noticeable on October 5th that the soil of the plots were heavily cracked.

Second Sowing date.

Owing to shortage of seed the spacing experiment could not be repeated at a second sowing date. 1.2 feddans of the Debeira variety were sown on 19/8 and harvested on 19/11 giving an average yield of 78 rotls per feddan. This sowing also suffered heavily from caterpillar attack on the upper leaves and buds in September and October.

SESAME

I. EXPERIMENT OF FALLOW DISCED AND VIRGIN LAND.

A replicated but unrandomised experiment on virgin and fallow disced land at Camp II.

Plots 0.31 feddan, sown broadcast by hand on 26/7.

Thinned 24/8. The sesame was sown much too thickly and was too thick even after thinning. Harvest 19/10. The crop grew away well but suffered from a fairly severe attack by sesame webworm (*Antigastra*) which attacked the pods before the crop was ripe and caused some loss of yield.

Variety. Um Hireihir (Quick maturing variety).

Yields.			Rotls per feddan.	
Virgin land	..	..	..	292
Fallow disced land	..	..	..	430

Yields were well up to the average obtained by cultivators in the district and that on fallow disced land may be considered good. Rain-fall at Camp II was 599.7 millimetres.

II. OBSERVATION PLOTS ON SECOND YEAR KOMODOB AT GHADAMBALIYA.

Two one feddan plots were sown on the experiment farm on the 9th of August. One plot was sown by drill in rows 36 inches apart and the other was sown broadcast by hand. Germination was good although the crop grew away rather slowly. These plots also suffered from attack by sesame webworm in October before harvesting on 23/10.

Variety. *Um Hireihir*.

Yields.					Rotls per feddan.
Broadcast plot	..	..	..	..	105
Drilled plot	..	..	..	..	75

These plots were sown too late to give reasonable yields. Rainfall was 100 mms less than at Camp II.

III. CONCLUSIONS.

Sesame should be able to take a place on the M.C.P. Scheme on *bildat* or on *komodob* land in the higher rainfall areas on the eastern boundary provided it is sown sufficiently early (preferably early July).

GROUNDNUTS

I. OBSERVATION PLOTS.

Sixteen different varieties of groundnuts were sown in 1/20th feddan observation plots on July 24th. Germination and growth were good but the crop suffered from a very severe attack of thrips during September and yields were very poor. The highest yield was given by the variety Barberton which gave 280 rotls per feddan.

II. BULK OBSERVATION PLOTS.

One feddan each of the varieties Barberton and Local Runner were sown by drill in 36" rows on August 1st. Germination was rather poor and the stand was patchy and was later heavily thinned out by termite attack. Both varieties suffered heavily from thrips and yield was very poor.

III. CONCLUSIONS.

Groundnuts must be sown by the end of June if they are to give a reasonable yield and if they are to escape heavy damage from thrips which move off leguminous plants in uncultivated land as they dry out in September. The rainy season is not sufficiently long on the M.C.P. Scheme and early sowing cannot be carried out every year. Groundnuts are therefore unlikely to find a place in the cropping system except for small areas in cultivators' *bildat* in years when early rains are favourable.

LEGUMINOUS FORAGE AND PULSE CROPS

A variety of leguminous crops was sown on observation plots on the experiment farm in 1/20th feddan plots.

I. GRAM.

3 varieties of green gram and 2 varieties of black gram were sown on July 24th. All made vigorous growth but suffered very severe damage from blister beetles in September which stripped the plants of flower buds as soon as they appeared ; yields of seed were very much reduced.

<i>Yields</i>		<i>Rotls per feddan</i>
L. 4 Green gram—Shambat	.. ..	320
L. 5 Green gram—E.C.R. 65	.. ..	70
L. 6 Black gram—E.C.R. 63	.. ..	200
L. 8 Black gram—E.C.R. 64	.. ..	190
L.14 Green gram—E.C.R. 120	.. ..	80

The variety L. 4 is the most vigorous and gives the highest yield of seed.

One feddan plots of the varieties L. 4, L. 5, L. 14 were sown by drill on August 1st but owing to the attacks of blister beetle hardly any seed was set.

Jassids were present in large numbers in the crop in September but appeared to be doing little damage.

II. COWPEA.

7 varieties of cowpea were sown on 24/7 the varieties being as follows : ECR/77, 78, 79, 169, 207, 209, 503.

Excellent growth was made by all varieties except ECR/207 which failed to germinate. The plants were however almost entirely stripped of buds by blister beetles and failed to set seed. The highest yield was given by ECR. 209 which gave 90 rotls per feddan ; this variety also has strong vegetative growth and gives a good ground cover.

Some leaf shedding was noticed due to the attack of thrips.

III. SUNN HEMP.

Two varieties of sunn hemp were sown. They came into flower when only 4 ft high and failed to set seed as the result of blister beetles eating the buds.

IV. JACK BEAN.

Failed to set seed.

V. TEPARY BEAN (*Phaseolus aconitifolius*).

A 1/20th feddan plot sown on 24/7 grew away well and gave a yield of 400 rotls per feddan. It was not attacked by blister beetle.

A one feddan plot sown by drill on August 1st gave a yield of 177 rotls. This is a quick maturing crop with low water requirement ; it ripens within 90 days of sowing and produced a bean very similar to but smaller than the haricot bean.

VI. LUBIA.

One feddan of lubia was sown by drill on the experiment farm on August 9th. The crop grew away well but the growing season was too short to give a good yield. The crop was cut on the 21st October ; the yield of green fodder per feddan being 3,683 rotls. Very much heavier yields could be obtained by sowing in early July when possible. This crop will not flower or produce seed at the M.C.P.S. as it is a " short day " crop.

VII. PHILLIPESARA. (*Phaseolus trilobus*).

This cover crop again made good vegetative growth but failed to set much seed as a result of blister beetle attack.

VIII. CLUSTER BEAN.

A plot sown by hand on July 24th grew away well and gave a yield of 490 rotls per feddan. This crop was not attacked by blister beetles or any other pests. A one feddan plot was sown by drill on August 1st and grew well. Yield is not available.

IX. SOYA BEAN.

Four varieties of soya bean were sown ; growth was poor and they failed to produce seed.

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X. CONCLUSIONS.

Gram, cowpea, tepary bean, lubia and cluster bean are worth further trial with the object of introducing a leguminous crop into the rotation. All should be sown as early as possible to ensure the longest possible growing season and to avoid the attacks of blister beetles and other pests which migrate into the crop from surrounding uncultivated land towards the end of the rains. Large areas should be sown (say 20 feddans) as small plots concentrate these pests and suffer very severely.

COTTON

I. SPACING EXPERIMENT ON 2ND YEAR KOMODOB.

Variety. BAR. SP. 84. Sowing date 24/7. 5 replications. 1/10 feddan plot. Germination was good but further growth was slow and root development poor and the stand was much thinned out by termites. Blackarm damage and thrips attack were light. Grasshopper nymphs caused considerable damage to the leaves in November.

<i>Spacing.</i>	<i>Yield (r.p.f.)</i>
90 x 90 cms.	165
90 x 60 cms.	200
90 x 30 cms.	225

The closest spacing gives the highest yield but differences are not significant. Growth was markedly poorer and yield was lower than at Ghadambaliya in 1947 in spite of the much higher rainfall in 1948.

A further area of 1 feddan was sown on 19/8; the stand was very heavily reduced by termite attack and yield was only 60 rotls.

II. FALLOW DISCED EXPERIMENT. Camp II.

A replicated but unrandomised experiment at Camp II comparing cotton on fallow disced and virgin land.

Variety. BAR. SP. 84. Sown 26/7. Size of plot 0.31 feddan. 4 replicates. Spacing 90 x 60 cms.

	<i>Yield (r.p.f.)</i>
Fallow disced land	200
Virgin land	195

Growth was poor both on virgin and fallow disced land. Blackarm and thrips both caused only slight damage. Termite damage was more severe on the fallow disced land and caused considerable reduction of stand.

III. CONCLUSION.

Yields of American cotton in the Ghadambaliya and Camp II areas are too low to give an economic return. Taking the value of seed cotton at £E. 3.000 m/ms. per feddan, the return would be considerably less than that obtained from dura.

MISCELLANEOUS CROPS

JUTE. Four varieties of jute were again sown. Good yields of seed were obtained but vegetatively the crop was useless for fibre.

DECCAN HEMP. Three varieties were sown. The crop suffered very severely from flea-beetle and growth was poor.

MAIZE. 2 varieties were sown, Shendi Hegiri and a grasshopper resistant variety from the plant breeding section. Growth was poor and no cobs were set.

CAMPHOR. The seedlings were washed out by rain just after germination or buried by mud.

II. Groundnuts Experiments at Sungikai

Kordofan Province.

by

T. R. G. Moir.

Sungikai (lat. 12°21' N long. 29°46' E) lies in an area of sandy soil, on which trials with the use of bull or tractor-drawn implements have recently been started.

Rainfall records were only begun in 1948, but the monthly rainfall should be fairly similar to that of Dilling which lies 30 miles to the south of Sungikai. The following are the figures for Dilling (average of 32 years) in mms. :

December—February	..	..	..	Nil
March	..	..	..	1.5
April	..	..	..	10.6
May	..	..	..	57.1
June	..	..	..	90.8
July	..	..	..	164.0
August	..	..	..	167.0
September	..	..	..	120.0
October	..	..	..	53.0
November	..	..	..	1.0
TOTAL	..	..	665.0	

The rainfall of Sungikai in 1948 was probably slightly above average. August rainfall was exceptionally heavy, while September and October rainfall was low. Hot, dry winds set in at the beginning of October and continued for about 10 days with the result that the groundnut plants wilted severely and harvesting began some 14 days earlier than is usual. The yield of the local runner variety was undoubtedly reduced as a result, but the earlier, bunch variety, Barberton, was already fully ripe by then and was probably little affected.

EXPERIMENTAL AREA

The experimental area consisted of 25 feddans cleared from scrub close to the 1947 cultivated plot. Judging by the growth of the bushes the land was probably abandoned from cultivation some 7 or 8 years ago. The area is rectangular running more or less north and south and also running down the slope leading towards Khor Abu Habl. Considerable sheet erosion and some gulying occurred during the heavy rainstorms in August and was most severe on the variety—spacing trial which was drilled parallel to the slope. Water as well as wind erosion must therefore be taken into account when laying out areas for future development.

EXPERIMENTS.

I. VARIETY—SPACING TRIAL. (3 Sowing dates).

Varieties—Barberton (bunch) and Beladi Runner.

Owing to the fact that the seed reserved for the experiment was mixed up during decortication some Beladi "Runner" from the 1947 crop was sown. This proved to be a complete mixture of runner and semi-bunch types and gave a very poor establishment so that the results for this variety are of little value.

Spacings. The plots were sown by Massey Harris drill in rows 30 inches apart the drill being set to give average spacings as follows :—

A	6"	Drill gear	8 (9 tooth sprocket).
B	12"	" "	6 (6 tooth sprocket).
C	18"	" "	3 (6 tooth sprocket).
D	24"	" "	1 (6 tooth sprocket).

In practice the drills were found to sow very irregularly and actual spacings were found to be very much wider than this. In calibrating the drills (a wheel was jacked up and turned by hand) allowance was made for broken seed and for a percentage germination of 80 per cent. In practice the drills probably broke a greater proportion of seed when working fast and germination was less than 80 per cent. In the hand sown variety trial, percentage germination was calculated to be 71 per cent for Barberton and 68 per cent for Beladi "Runner"; percentage germination of seed sown by drill is probably less than this. The "twelve" inch spacing is equivalent to a seed rate of 20 rotls of shelled seed per feddan.

(A) *First Sowing Date.* Sown 28/6.

Cultural Operations. Discd twice. Hand weeded on 28/7 and 15/8. Size of plot 1/12th feddan. 5 Replicates. Harvested: Barberton 10/10, Beladi Runner 25/10.

Yields (rotls).

Barberton.

	Spacing	Effective spacing	Yield per plot	Yield per feddan
A	(6")	11.7"	78.8	945.6 rotls
B	(12")	18.2"	65.4	784.4 "
C	(18")	25.1"	50.7	608.4 "
D	(24")	34.7"	37.7	452.4 "

Analysis of variance was carried out for the Barberton variety only.

Treatment A is significantly better than C and D but the difference between A and B is not significant at the 1 per cent level.

Standard error of each plot	..	..	..	= 8.63 rotls.
Coefficient of variance	..	..	..	= 14.9 per cent.
Significant difference of plot means	..	..	..	= 16.4 rotls.

Beladi Runner.

	Spacing	Effective spacing	Yield per plot	Yield per feddan
A	(6")	30.1"	45.6	547.2 rotls
B	(12")	43.0"	35.0	420.0 "
C	(18")	50.6"	27.3	327.6 "
D	(24")	85.1"	20.4	244.8 "

The analysis of variance was not carried out. The closest spacing is obviously the best but is still too wide. Establishment of this " variety " was very much worse than that of the local beladi variety sown in the main areas.

(B) *Second sowing date. Sown 19/7.*

Cultural operations. Disced three times; hand weeded 11/8. Size of plot 1/12 feddan. 5 replicates. Harvested : Barberton 20/10, Beladi " Runner " 1/11.

Yields (rotls).

Barberton.

	Spacing	Effective spacing	Yield per plot	Yield per feddan
A	(6")	21.5"	18.9	226.8 rotls
B	(12")	29.6"	15.9	190.8 "
C	(18")	32.5"	13.1	157.2 "
D	(24")	50.0"	10.3	123.6 "

Establishment and yields from this sowing date were exceptionally poor being considerably poorer than the third sowing date. A 33 millimetre fall of rain occurred on the day after sowing and germination and establishment might have been expected to be good. The closest spacing is obviously the best although differences are not significant except between A. and D.

Standard error of each plot = 3.27 rotls.

Coefficient of variance = 22.5 per cent.

Significant difference of plot means = 6.3 rotls.

Beladi " Runner ".

	Spacing	Effective spacing	Yield per plot	Yield per feddan
A	(6")	33.3"	10.9	130.8 rotls
B	(12")	50.0"	5.5	66.0 "
C	(18")	64.5"	4.6	55.2 "
D	(24")	70.0"	5.1	61.2 "

The yield of this variety is even worse than that of Barberton and establishment correspondingly poorer. The plots on this sowing date all suffered from fairly heavy sheet erosion.

(C) *Third sowing date. Sown 27.7.*

Cultural operations. Discd three times. Hand weeded 11/8. Size of plot 1/12 feddan. 5 replicates. Harvested : Barberton 22/10, Beladi 1/11.

Yields (rotls).

Barberton.

	Spacing	Effective spacing	Yield per plot	Yield per feddan
A	(6")	12.1"	33.0	396.0 rotls
B	(12")	17.9"	21.4	256.8 „
C	(18")	23.5"	21.0	252.0 „
D	(24")	40.0"	11.5	138.0 „

The closest spacing A gives a significantly higher yield than all other spacings.

Standard error of each plot	.. .. .	= 4.36 rotls
Coefficient of Variance	.. .. .	= 20.1 per cent.
Difference between treatment means for significance	.. .. .	= 8.4 rotls.

Beladi " Runner ".

	Spacing	Effective spacing	Yield per plot	Yield per feddan
A	(6")	27.4"	12.5	150.0 rotls
B	(12")	44.9"	10.6	127.2 „
C	(18")	61.6"	8.0	96.0 „
D	(24")	76.9"	6.9	82.8 „

The closest spacing again gives the highest yield.

(D) *Conclusions.*

Sowing date. The earliest sowing date gave by far the highest yields. The yield from the second sowing date is unaccountably low.

Variety. Barberton gives a higher yield throughout than the Beladi " Runner " variety although at equivalent plant densities yields run about the same. The decrease in yield with advancing sowing date is less marked with Barberton than with Beladi " Runner ".

Spacing. The closest spacing gave the highest yield throughout. For the Barberton variety this worked out as an average spacing of approximately 12" between plants in the 30" row and is equivalent to a seed rate of about 30 rotls per feddan. Judging by the appearance of the crop during growth this looked quite close enough but a higher seed rate might give a still higher yield. For the Beladi " Runner " variety the closest spacing worked out an average of 30 inches between plants which is too wide. In the main areas the establishment of the locally obtained runner variety was far better than that of the very mixed Beladi Runner in the experiment.

II. VARIETY TRIAL (2 Sowing dates).

Varieties.

A Beladi (Saata)—Runner variety.

B Beladi (local)—The main crop runner variety.

C Barberton. Erect bunch type.

D Abu Arbaa. Erect bunch type. Equals "Kordofan Central Africa."

E Beladi "Runner". Mixture of runner and bunch types.

F American. Large podded semi-erect bunch type.

G Ashfords. Like American but pods slightly smaller.

The trial was sown by hand at a spacing of 30" x 12" throughout. Size of plot 1/10 feddan. 5 replicates. Two seeds were sown in each hole

(A) *First Sowing date. Sown 3/7.*

Cultural operations. Discd twice; hand weeded 29/7.

Harvesting dates: Barberton 10/10, All other varieties 20/10.

Yields (rotls).

			% Blank holes	% Germina- ton.	% Termite damage.	Yield per plot	Yield per Fed.
A	Beladi Saata	..	5.7%	76%	0.5%	61.4	614
B	Beladi Local	..	6.7%	74%	0.3%	67.9	679
C	Barberton ..	..	8.7%	71%	1.9%	79.3	793
D	Abu Arbaa	..	8.6%	71%	1.2%	57.2	572
E	Beladi "Runner"	..	10.0%	68%	1.0%	54.8	548
F	American ..	..	9.6%	69%	1.6%	60.6	606
G	Ashfords ..	..	6.9%	74%	1.9%	75.5	755
Standard error of each plot			..	..	..	=10.9 rotls.	
Coefficient of variance			..	..	..	=16.7 per cent	
Significant difference between mean plot yields..			=13.7 rotls.				

The varieties Barberton and Ashfords give significantly higher yields than Beladi Saata, Abu Arbaa, Beladi "Runner" and American. The yield differences between Barberton, Ashfords and Beladi local are not significant.

Shelling out percentage.

Yield shelled nuts/feddan

A	Beladi Saata	71.2%	437	rotls.
B	Beladi Local	70.5%	479	"
C	Barberton	74.5%	590	"
D	Abu Arbaa	65.6%	375	"
E	Beladi "Runner"	69.5%	381	"
F	American	63.2%	383	"
G	Ashfords	59.2%	447	"

The shelling out percentage of Barberton is exceptionally good, that of the Beladi varieties is good, Abu Arbaa and American are poor and Ashfords is exceptionally bad.

(B) *Second sowing date. Sown 19/7.*

Harvesting date. Barberton 19/10, all other varieties 25/10. The American variety was not included owing to shortage of seed.

	<i>Yields (rotls)</i>	% Blanks	% Germination	% Termite damage	Yield per plot	Yield per feddan
A	Beladi Saata ..	11.7%	66%	0.4%	30.0	300
B	Beladi Local ..	8.9%	70%	0.8%	28.1	281
C	Barberton ..	6.3%	75%	1.2%	50.6	506
D	Abu Arbaa ..	93.6%	3%	0.8%	2.9	29
E	Beladi " Runner " ..	12.6%	65%	0.6%	14.4	144
F	Ashfords ..	9.7%	69%	1.0%	25.3	253

Standard error of each plot = 7.33 rotls.

Coefficient of variance = 34.4 per cent.

Significant difference of mean plot yields = 13.2 rotls.

Barberton significantly outyields all other varieties and is obviously of special value for late sowings. Seed of the Abu Arbaa variety had sprouted in the bag before sowing and germination was very poor.

The vigorous but slow maturing Ashford variety gave a poor yield at this sowing date. The Beladi " Runner " used in the spacing experiment was also exceptionally poor.

(C) *Conclusions.*

Barberton gives the highest yield and is outstanding for the later sowing date ; it also gives the highest shelling out percentage. The local runner variety gave a good yield at the first sowing date and has a good shelling out percentage.

Ashfords gave a high yield the first sowing date but shelling out percentage is very poor.

III. MANURIAL OBSERVATION TRIAL.

The following fertiliser treatments were tried out in all combinations in an unreplicated observation trial.

Ammonium nitrate	..	..	..	100 rotls/feddan.
Sulphate of potash	..	..	..	100 rotls/feddan.
Superphosphate	..	..	..	200 rotls/feddan.
Superphosphate	..	..	..	400 rotls/feddan.

(A) *First sowing date. Sown 4/7.*

Size of plot = 1/10 feddan. Fertilisers applied broadcast, 20/7. Harvested, 17/10. Variety. Mixed Runner and Bunch variety ; the so called Beladi " Runner ". Spacing, 30" x 12".

Yields. Rotls per feddan.

TREATMENTS.

	O	N	K	N+K	Mean
O	780	615	740	705	710
P	1120	1055	985	725	971
2P	1050	1000	1250	1010	1077
Mean	983	890	992	836	

Increase or decrease in yield due to fertiliser treatments. (comparison of mean values) over control.

Treatment		Increase or Decrease (r.p.f.)
Superphosphate.	200 r.p.f.	+ 261
Superphosphate.	400 r.p.f.	+ 367
Ammonium nitrate.	100 r.p.f.	— 97
Sulphate of potash.	100 r.p.f.	+ 9
Ammonium nitrate with Sulphate of potash.	100 r.p.f. } 100 r.p.f.	— 147

Shelling out percentage. (Mean of 2 samples).

TREATMENTS.

	O	N	K	N+K	Mean
O	69.5	68.7	67.2	64.5	67.5
P	69.7	68.7	69.0	66.7	68.5
2P	69.7	68.7	68.7	65.7	68.2
Mean	69.6	68.7	68.3	65.6	

Nitrogen and potash fertilisers both cause a slight decrease in shelling out percentage and when applied together decrease shelling out percentage by 4 per cent.

Phosphate fertiliser gives a slight increase in shelling out percentage.

(B) *Second sowing date. Sown 20/7*

Fertiliser distributed 5/8. Harvested 25/10.

Variety—Beladi Bunch with some admixture of Runner.

Spacing—30" x 12". Plot size 1/10 feddan.

Yields. Rotls per feddan

TREATMENTS.

	O	N	K	N+K	Mean
O	510	370	285	400	391
P	840	625	780	505	687
2P	730	605	820	600	690
Mean	693	533	630	502	

Increase or decrease in yield due to fertiliser treatments (comparison of mean values) over control.

Treatment.		Increase or decrease (r.p.f.)
Superphosphate.	200 r.p.f.	+ 296
Superphosphate.	400 r.p.f.	+ 299
Ammonium nitrate	100 r.p.f.	— 160
Sulphate of potash	100 r.p.f.	— 63
Ammonium nitrate with Sulphate of potash	100 r.p.f. } 100 r.p.f.	— 191

(C) *Conclusions.*

Ammonium nitrate gives a well marked reduction in yield as compared with control.

Potassium sulphate has little or no effect on yield when alone but when applied together with ammonium nitrate the reduction in yield is greater than that due to nitrate alone. Superphosphate applied at the rate of 200 rotls per feddan gives an increase in yield of 261 and 296 rotls/feddan at the 1st and 2nd sowing dates respectively. At the rate of 400 rotls per feddan there is a further increase of 106 and 3 rotls per feddan at the two sowing dates.

During the growing season vegetative vigour was markedly increased by phosphate and also by nitrogen. On October 10th when the crop was wilting badly the control plot was showing the least wilting and crops manured with nitrogen and potash were wilting more markedly than those given phosphate alone.

At 1948 Sudan prices for groundnuts, the application of phosphate would apparently not be economic, unless there was a considerable residual effect on the next year's crop.

IV. RIDGING EXPERIMENT.

A replicated experiment comparing the effect of sowing on ridges with sowing on the flat.

Plots 1/10 feddan sown by hand at 30" x 12" spacing. Variety—Beladi "Runner" (mixed Bunch and Runner).

(A) *First Sowing Date. Sown 4/7. Harvested 17/10.*

<i>Treatment</i>	<i>Mean Yield/plot</i>	<i>Yield/feddan</i>
Ridge	40.4 rotls.	404 rotls.
Flat	50.9 rotls	509 rotls.
Standard error of each plot	= 5.03 rotls.	
Coefficient of variance	= 11.0 per cent	
Significant difference between means	= 8.8 rotls.	

Plots sown on the flat significantly outyield plots sown on the ridge.

(B) *Second Sowing Date. Sown 20/7. Harvested 25/10.*

<i>Treatment</i>	<i>Mean Yield/plot</i>	<i>Yield/feddan.</i>
Ridge	31.0 rotls.	310 rotls.
Flat	41.9 rotls.	419 rotls.
Standard error of each plot = 1.23 rotls.		
Coefficient of variance = 3.3 per cent.		
Significant difference between means = 2.2 rotls.		

Plots sown on the flat again significantly outyield plots sown on the ridge.

V. VARIETY OBSERVATION PLOTS. Sown 20/7. Harvested 19/10.

<i>Variety</i>	<i>Area</i>	<i>Yield/</i> <i>feddan</i>	<i>Remarks.</i>
	feddan	rotls	
Virginia Bunch ..	.08	461	Erect resembles Barberton.
Zande	.125	312	Same as "Abu Arbaa".
Abu Arbaa	.15	285	Erect bunch variety.
Kordofan Central Africa	.16	404	Same as Abu Arbaa.
Jur	.16	324	Intermediate semi-bunch.
Bari	.12	301	Mixed runner semi-bunch.
Indian	.11	276	Runner variety.
Giza bunch	.09	246	Intermediate semi-bunch.
Kalindi	.075	240	Runner variety.
Big Japan	.025	240	Intermediate semi-bunch.

Yields on the whole were poor. Abu Arbaa, Zande and K.C.A. varieties all showed a proportion of the crop germinating in the ground before they were ready for harvesting.

Virginia Bunch is the only variety worth further trial.

YAMBIO EXPERIMENTAL FARM

by K. R. M. Anthony.

RAINFALL.

Rains began in the middle of February and after a dry period in the latter half of March and beginning of April remained fairly well distributed, with the exception of a dry spell in the first three weeks of July. They ended abruptly at the beginning of November. Rainfall data recorded at the Yambio Post Office is given below in pentades.

TABLE I.

1948 Rainfall data. Yambio Post Office in mms.

Month	Pentade						1948 Total	Average (12 years) Total
	1—5	6—10	11—16	16—20	21—25	26—31		
January	Nil	Nil	Nil	Nil	Nil	Nil	Nil	16.8
February	Nil	Nil	Nil	6.3	16.1	5.2	27.6	35.3
March	12.1	54.4	21.5	Nil	Nil	11.2	99.2	83.7
April	3.0	0.5	41.8	28.4	63.7	9.7	147.1	168.7
May	5.3	42.9	67.2	0.6	5.8	124.5	246.3	174.6
June	9.7	11.7	76.0	13.0	19.3	18.1	147.8	185.9
July	Nil	Nil	1.5	Nil	67.5	90.5	159.5	188.5
August	2.6	36.1	38.3	60.3	56.0	84.0	277.3	214.4
September	31.8	32.8	11.8	2.6	81.8	10.4	171.2	188.0
October	15.0	19.3	2.4	21.9	60.0	62.3	180.9	142.1
November	Nil	Nil	Nil	0.5	Nil	Nil	0.5	89.0
December	Nil	Nil	Nil	Nil	Nil	Nil	Nil	16.8
TOTAL							1457.4	1503.8

COTTON.

I. SEED DETERIORATION.

Very poor germination of cotton seed in Equatoria in the last three seasons has aroused considerable anxiety and its cause was given number one research priority.

In December 1948 the Plant Pathologist visited Yambio and in cooperation with Agronomist, Yambio carried out initial observations on the problem. This work is summarised in the following notes.

Examination of a large number of samples indicated that seed could be classified into five main groups :—

Group 1. Normal (heathy) seed. Endosperm smooth, firm creamy white,

Group 2. As (1) but with a distinct yellowish staining of the endosperm. In some cases the yellowing appeared to originate from the side of the endosperm and all stages from light yellow spots to a darker yellow or orange colour throughout the whole of the endosperm were found.

Group 3. Endosperm reduced to a disintegrated brown or black powder.

Group 4. Endosperm soft and green or dark brown—not powdery

Group 5. Endosperm more or less completely shrivelled—in some cases almost non existent. The cause presumably being physiological.

Gradations between these groups were found. Unless otherwise stated, for records Group (1) was termed normal, Group (2) yellow and Group (3), (4) and (5) rotten.

(a) *Germination of cotton from different picking dates.*

Samples of cotton were taken from different sowing dates on the Sowing Dates Experiment at the YEF. From each a sample of 100 seeds was cut open, examined and classified as above. Also a germination test was carried out on five lots of a hundred seeds each.

TABLE 2.

Cotton seed sample from sowing dates experiment.

Sample No.	Picking Date	Sowing Date	% Germination	% Seed		
				Normal	Rotten	Yellow
94	8.10.48	15. 5.48	77	72	9	19
78	15.10.48	15. 5.48	80	77	5	18
87	16.10.48	30. 5.48	71	77	13	10
60	21.10.48	15. 5.48	80	78	9	13
93	1.11.48	15. 5.48	67	70	13	17
90	4.11.48	15. 6.48	56	61	14	25
92	8.11.48	15. 5.48	56	59	15	26
85	10.11.48	30. 5.48	52	57	16	27
82	11.11.48	15. 6.48	54	59	13	28
84	13.11.48	30. 6.48	60	57	18	25
86	16.11.48	15. 5.48	51	52	19	29
62	16.11.48	15. 6.48	53	49	25	26
89	20.11.48	30. 6.48	53	57	11	32
63	23.11.48	15. 6.48	58	50	25	25
91	24.11.48	30. 5.48	48	43	17	40
83	29.11.48	15. 7.48	49	46	26	28
41	1.12.48	15. 5.48	47	44	17	39
45	2.12.48	15. 6.48	50	53	27	30
42	7.12.48	15. 7.48	49	45	21	34
59	11.12.48	15. 6.48	42	51	32	17
43	15.12.48	15. 7.48	34	41	33	26
64	23.12.48	15. 7.48	27	21	64	15
61	23.12.48	15. 6.48	25	26	45	29

All germination tests and visual examination were carried out in the second half of December.

Percentage of normal seed corresponds closely to the percentage germination. There is a remarkable decrease in viability from the beginning to the end of the picking season, the percentage of normal seed decreasing with lateness in season.

It has been suggested that a contributory cause of rotten seed may be heavy rains prior to picking. Table 3 gives the distribution of autumn rainfall at the Experimental Farm during 1948. Whilst it was observed that in some cases a small proportion of the cotton, picked after heavy rains towards the end of October, put out radicles on the drying floor, loss of viability appears to bear little relationship to distribution of rainfall provided every precaution is taken to dry the seed thoroughly after picking.

TABLE 3.

Autumn Rainfall recorded at YEF. 1948.

Pentade	September	October	November	December
1—5 ..	24.8	15.0	28.2	Tr.
6—10 ..	32.8	19.3	Nil	Nil
11—15 ..	11.8	4.4	Nil	Nil
16—20 ..	2.6	19.9	0.5	Tr.
21—25 ..	81.8	107.8	Nil	Nil
26—31 ..	10.4	14.5	Tr.	Nil
TOTAL	164.2	180.9	28.7	Tr.

In mid-December cotton stainers (*Dysdercus* sp.) were very numerous on cotton examined and were generally inside the open bolls, feeding on the seed. Field records of the sowing dates experiment showed that whilst stainers were occasionally found in cotton in September, they were fairly common in October, widespread in November and heavy in December. Bollworms were frequent but not to the extent of the stainers. *Helopeltis* was general but, although it may feed on the boll, it does not apparently attack the seeds. However the preferred food of the stainer bug appears to be ripe seed and in large numbers it seems probable that they will have an appreciable adverse effect on germination. The general impression gained was that the higher proportion of seed which had been damaged at the time of picking was due to stainer damage.

As there is a progressive decrease in viability of cotton seed with later pickings it is to be expected that there would be a similar decrease in viability through the ginning season, as later ginnings are normally from later markets and hence later pickings. Samples taken from Nzara ginnery at weekly intervals confirm this.

TABLE 4.

Cotton seed samples taken from Nzara ginnery.

Sample No.	Grade	Date	% Germination	% Seed		
				Normal	Rotten	Yellow
58	I	21. 12. 48	74	80	5	15
10	I	30. 12. 48	72	72	11	17
14	I	5. 1. 49	74	80	9	11
16	I	10. 1. 49	60	58	24	18
18	I	17. 1. 49	74	76	14	10
17	I	20. 1. 49	65	61	20	19
19	I	24. 1. 49	62	68	20	12
21	I	1. 2. 49	57	61	26	13
22	I	7. 2. 49	57	62	20	18
23	I	14. 2. 49	50	53	38	9
24	I	21. 2. 49	62	66	27	7
113	3	25. 2. 49	43	44	48	8
104	3	8. 3. 49	45	51	45	4
103	3	16. 3. 49	44	47	49	4
38	I	24. 3. 49	59	46	42	12
39	I	29. 3. 49	62	51	40	9
108	I	7. 4. 49	67	51	32	17
30	2	3. 5. 49	61	57	33	10

Samples 38, 39, 108 were ex Grade 1 cotton from the later markets. In all three cases visual examination revealed a general light greening of the endosperm.

The high proportion of rotten seed is alarming as it is planned to utilise the seed for oil production in future seasons. Representative samples have been dispatched to Government Analyst, Khartoum who has kindly consented to do oil content analyses.

(b) Storage Problems.

Whilst stainer bugs may be responsible for damage to cotton seed in the field, bad storage conditions may also result in reduced viability. Warm moist conditions are favourable to organisms capable of bringing about fermentation. De Saeger (Bull. Agric. du Congo Belge Vol. XXXVII No. 3. 1946) suggests that fermentation of whole heaps of cotton may result from the wetting of only a small portion of it.

A number of one ardeb sacks of cotton seed were kept under observation at the Experimental Farm under different treatments to test whether De Saeger's assertion applied to seed stored under normal local practice.

Treatments were :—

- (i) Cotton seed, control. Untreated.
- (ii) Cotton seed, centre of sack thoroughly wetted.

- (iii) Cotton seed, two rotls of badly deteriorated seed added to centre.
- (vi) Cotton seed, centre of sack thoroughly wetted and badly deteriorated seed added.
- (v) Seed cotton, control. Untreated.
- (vi) Seed cotton, centre of sack thoroughly wetted.
- (vii) Seed cotton, two rotls of badly deteriorated seed added to centre.
- (viii) Seed cotton, centre of sack thoroughly wetted and badly deteriorated seed added.

Sacks were stored on wooden trestles in a grass hut with a good thatch roof. The seed was ex Nzara ginnery, December 1948.

Samples were taken from each sack every month for visual examination and germination test. Data for the first, third and fifth samplings are given in table 5.

TABLE 5.

Experimental Farm Storage experiment.

Treat	Sampled 5.1.49				Sampled 15.3.49					Sampled 14.5.49				
	% Ge	N	R	Y	% Ge	N	G	R	Y	% Ge	N	G	R	Y
i	68	74	12	14	67	68	2	18	12	66	65	10	20	5
ii	69	79	9	12	64	60	3	26	11	62	60	12	22	6
iii	70	77	6	17	66	63	3	23	11	67	67	7	22	4
iv	71	77	7	16	62	56	9	28	7	62	61	12	20	7
v	75	83	12	5	63	64	18	12	6	67	62	21	16	1
vi	76	82	14	4	62	53	23	19	5	63	60	20	19	1
vii	77	83	5	12	67	54	26	15	5	71	55	24	16	5
viii	75	78	10	12	65	51	22	20	7	70	51	25	21	3

% Ge = percentage germination.

N = Group 1. G = Group 4. R = Groups 3 & 5. Y = Group 2.

Allowing for sampling error, germination tests indicated no loss in germination of these samples up to one month prior to the normal sowing date. Visual examination revealed some deterioration in all the samples. This took the form of a general greening of the endosperm and first became apparent in the March samples. The colour intensity varied considerably in all shades from a light green to the dark green of group IV of our original classification. In the samples taken from the Cotton Sowing Dates experiment and from Nzara ginnery (with the exception of the last three Grade 1 samples), the percentage of green seed was negligible and was included under the general term 'rotten.' However as this group appeared to represent a very separate and important form of deterioration it was decided to record it separately where it occurred in later samples. Where a very slight greening only of the endosperm occurred the seed was still classified as normal and

a standard dark green was arbitrarily taken at which it was classified under Group 4. This was not an entirely satisfactory method of discrimination and accounts for apparent discrepancies between percentage germination and seed classified as normal by visual examination. It does however give some indication of the progress of deterioration. In the final stages the seed has a soft deep green or greeny brown endosperm.

In old seed samples a soft dark brown rot often occurs. This is also included in Group 4 as it is considered to be a similar form of deterioration occurring under conditions of heating. A sample of cotton picked from a peasant's holding in December 1947 and stored in a tightly packed basket when examined in May 1949 was found to contain 43 per cent of Group 4 (green and brown), the remaining 57 per cent being rotten seed of groups 3 and 5.

The deterioration appears to be occurring more rapidly in the sacks of seed cotton, but no definite conclusions can be drawn from this. Although all samples were sun dried before storage, in the absence of facilities for doing moisture contents, there is no evidence that seed cotton may not initially have had a higher moisture content than the cotton seed. Rusca and Gerdes, (U.S. Dept. Agric. Circ. 651 1942) assert that the drying of seed cotton has little effect upon the moisture content of the seed. So that the drying of the seed cotton was probably less effective than that of the cotton seed.

There is no evidence of the spread of fermentation from the foci of wetted or deteriorated seed. However conditions were not such as to favour fermentation. The risk of fermentation starting and rapidly spreading is greatest where seed is stored in bulk without adequate ventilation and consequent danger of heating.

Table 6 gives data obtained from a large heap of seed cotton stored under cover in a corrugated iron shed for a period of four months and sampled periodically until ginning. Again greening appeared in the later samples.

TABLE 6.

Samples from a heap of seed cotton at Nzara Ginnery.

Sample	Date of Sampling	% Germination	% Normal	% Green	% Rotten	% Yellow
20	24. 1.49	66	64	0	21	15
108	7. 2.49	61	63	0	24	13
101	21. 2.49	71	63	0	22	15
28	8. 3.49	65	62	12	18	8
55	7. 4.49	61	52	11	24	13

Three other samples were examined from cotton seed all from the same source but (i) stored with free exposure to the air (ii) stored in an airtight jar under conditions of low relative humidity (iii) stored in an airtight jar containing a tube of wet cotton wool to maintain a high relative humidity. Results from the initial sampling and after four months of storage are given in Table 7.

TABLE 7.
Humidity Experiment.

Treat	Sampled 5.1.49				22.5.49				
	% Ge	% N	% R	% Y	% Ge	% N	% G	% R	% Y
i	63	69	16	15	61	67	13	19	1
ii					70	74	1	20	5
iii					40	46	29	21	4

In treatment (ii) only one green seed was recorded after four months and only a negligible proportion of the normal seed showed slight greening. In treatment (i) a light greening of the endosperm was general and 13 per cent green seeds were recorded. In treatment (iii) considerable deterioration had occurred with a high proportion of green seed. This suggests that this form of deterioration is closely related to humid conditions during storage. Extensive greening of seed endosperm was first noted in March at the beginning of the rains and may be a result of increase in relative humidity causing an increase in the moisture content of the seeds and hence affecting their metabolism.

(c) Recommendations.

Following from this year's field observations and experiments the following precautions are suggested to minimise deterioration in cotton seed for sowing.

1. Try to ensure that the peasant does not leave his cotton unpicked in the field for long periods and consequently reduce the period in which the seed is subject to field damage—insect attack and unfavourable atmospheric conditions in the form of rainfall and high humidity.

2. Choose seed for sowing only from Grade 1 cotton from the first markets, to avoid seed badly damaged by stainers.

3. Take every precaution to ensure that the seed is dry. Not only should the cultivator dry his cotton after picking but also the ginned seed should be further dried before storing. Improperly dried seed may be more susceptible to changes in moisture conditions.

4. Store the seed in a cool, dry rainproof place.

It also seems advisable to carry out germination tests prior to storing.

II. FIELD TRIALS.

The bulk of the cotton was planted in the first week of June on newly cleared bush. Variety SP. 84 was used, standard planting distance being 90 cms x 45 cms thinned to 2 plants per hole. Germination of seed ex Semeiha was good, seed ex Meridi poorish. The crop made good growth and on the farm an average yield of 9.7 small kantars was obtained from early June sowing.

(a) *Pests and Diseases.*

Blackarm was first reported on early sown cotton on 19.6.48 but never became serious. *Ramularia* was present but light.

Jassids (*Empoasca* sp.) were noted in July and reached a peak in September—October when they caused general reddening of leaves and leaf shedding. The extent of their damage was difficult to assess.

Stainer bugs first observed in September, were common in October, widespread in November and very heavy in December when they were responsible for a high percentage of stained cotton.

Egyptian and pink bollworm, *Helopeltis*, *Lygus* and leaf miners were all recorded but were generally not serious.

(b) *Cotton Sowing Dates Experiment.*

Randomised block layout ; variety SP. 84 ; five sowing dates ; replicated 6 times ; subplot size 35 metres x 6 metres.

TABLE 8.

Sowing Date						Yield. small kantars (100 rotls) p.f.
May	15th	..	..	..	..	12.53
May	30th	..	..	..	..	10.54
June	15th	..	..	..	..	10.36
June	30th	..	..	..	..	8.96
July	15th	..	..	..	..	5.63

Standard Error = $\pm .38$.

Significant difference between treatments (at $P = 0.05$) = ± 1.13 .

Both in yield and quality results favoured the earlier sowings, confirming earlier experience. However the low yields of late sowings are to some extent the result of heavier insect damage, particularly from stainers which had multiplied on the earlier sowings, and results may be misleading. The present practice of sowing cotton in the first half of June seems to be near the optimum, ensuring that the crop is growing in the second half of the rains and that picking takes place at the commencement of the dry season.

(c) *Cotton Thinning and Spacing Experiment.*

An experiment to determine the optimum spacing and thinning of cotton in Zande district.

Cotton variety SP. 84 planted in rows 90 cms apart. Distance apart in rows 30 cms, 45 cms or 60 cms. Cotton thinned to 2 or 3 plants per hole. Six combinations of treatments, replicated six times. Size of subplot 17.5 metres x 10 metres.

TABLE 9.
Yields in small kantars (100 rotls) per feddan.

Thinning	SPACING			
	30 cms	45 cms	60 cms	Mean
2 plants/hole	9.60	9.31	10.31	9.74
3 " "	9.38	9.61	9.97	9.65
Mean	9.49	9.46	10.19	

At $P = 0.05$ differences are not significant.

Bearing in mind the eventual stand obtained the closer spacing is recommended for native plots.

(d) *Cotton Interplanting Experiment.*

If food crops could be interplanted amongst cotton without adversely affecting its yield, it would greatly add to its popularity with native cultivators. At present the Azande commonly interplant datiro (*Colocynthus citrullus* (L) Kunt). amongst their cotton.

This experiment compared cotton planted alone with cotton interplanted with datiro and maize.

Randomised block layout ; 4 treatments ; 5 replications ; plot size 194 sq.m. Cotton variety, SP. 84 ; sown in rows 90 cms x 80 cms 4.6.48 ; thinned to 2 plants per hole. Maize, Peruvian yellow one plant in centre of four cotton holes. Datiro sown similarly. When maize and datiro were both sown they alternated, a plant of either being sown between four cotton holes. Maize and datiro were interplanted at cotton thinning.

TABLE 10.
Yields of cotton in small k.p.f.

Treatment	Yield
Cotton alone	11.85
Cotton intersown with datiro	10.10
Cotton intersown with maize	9.85
Cotton intersown maize and datiro	8.87
Standard Error $\pm$.60.	

Significant difference between means at $P = 0.05$ is ± 1.83 .

Interplanting with maize, and maize plus datiro reduced yields significantly. The datiro yielded fairly well but maize was a complete failure, plants were stunted with small cobs and almost negligible yield. The condition of the maize was most probably due to the fact that the experiment was in newly opened bush a condition under which maize does not normally do well in this district. In any case interplanting with maize appears to have an adverse effect on cotton yield. Interplanting with datiro alone did not quite produce a significant decrease in yield. With the wide spacings of native cultivations it probably has a negligible effect on yield.

In Uganda interplanting with beans and bunch types of groundnuts is encouraged. Both seem worth consideration.

(e) *Cotton Manurial Trial.*

Two phosphatic manures ex Uganda, a rock phosphate and a silicophosphate were sent for trial at Yambio.

No other form of phosphate was available at the time to use as a standard and a comparison was made between control (no phosphate), and the two Uganda phosphates at a rate of 80 rotls $P_2 O_5$ per feddan. Randomised block layout, 5 replicates, plot size 105 sqm. Plots were split for a comparison of nitrogen x no nitrogen at 40 r.p.f. in the form of sulphate of ammonia. Cotton SP. 84 sown 3.6.48; fertiliser applied 1 day prior to sowing.

TABLE II.

Yield in small kantars per feddan.

		No. P	Silico P	Rock P	Mean
No nitrogen	..	8.37	8.29	7.73	8.13
Nitrogen ..	..	8.45	9.41	9.39	9.08
Means	.. ..	8.41	8.85	8.56	

Standard Error Nitrogen treatments $\pm$ 0.30.

Significant diff. between means = $\pm$ 0.91.

Phosphate and Interactions not significant at $P = 0.05$.

Application of nitrogen at the rate of 40 r.p.f. produced an 11 per cent increase in yield. Neither of the phosphate manures had a significant effect on the cotton yield, presumably as a result of fixation of the phosphate in an unavailable form.

(f) *Effect of removing tree stumps on cotton yield.*

The Zande practice, when clearing land for cultivation, is to cut back trees to a height of approx. two to three feet. No destumping is done. A small field experiment was carried out on a native holding comparing effect on cotton yields of destumping compared with no destumping. Two treatments, 6 replicates plot size 125 sq metres. The mean yield from plots on which stumps were left was 7.00 kantars and from destumped plots 7.08 kantars. If anything the not destumping practice is the better in that it probably hastens regeneration on leaving plots to return to bush.

TOBACCO.

A continuation of the work carried out by Inspector of Agriculture, Yambio in 1947. An area of approximately one feddan was put down to tobacco. The three varieties planted were the same as last year :— Virginian Hybrid, Western and Burley. Varieties were planted in six blocks of three plots each, in a replicated block pattern.

1. *Seed beds.*

Seed beds were carefully prepared for each variety, sterilised on June 1st, by brushwood fire and the seed sown a week later. Standard seed bed technique was adopted. As in the previous season grasshoppers attacked the seedlings and as a result there was insufficient Burley to sow its allotted area.

2. *Cultivation.*

Plots were cleared and dug in June, redug deeply and ridged up on 2.8.48, ridges 90 cms apart. The young plants were transplanted to the field on 9.8.48 at a spacing of 75 cms and a mixed fertiliser placed around each hole. Replanting was carried out where necessary. First plants were primed on 10.9. Firstflowers appeared on Virginian 16.9, on Burley 18.9, on Western 24.9. Plants were immediately topped and suckering began. 10—12 leaves were left per plant, Virginian being topped to 4', Burley to 3' and Western 3'6".

The first Burley leaves were mature and harvested on 14.10.48, Virginian 16.10.48 and the western 18.10.48.

3. *Pests and Diseases.*

Similar to last season.

- (a) Grasshoppers caused some damage to young plants in August, but were easily controlled by hand picking.
- (b) Cutworms appeared at the end of September feeding on the leaves, and caused considerable damage. Control was effected by hand picking.
- (c) *Cercospora* leaf-spot (identified by Plant Pathologist) appeared in mid September and rapidly spread to all plots.

- (d) Virus diseases were again severe. Mosaic appeared on a high percentage of Burley plants in early September and rapidly spread to the other varieties. Leaf curl also occurred on occasional plants.

4. *Curing.*

A grass barn was built at the farm on the Uganda pattern recommended by Mr. Lea-Wilson ; viz-36 ft. x 20 ft. with walls 6 ft. high and roof tree 20 ft. above. This size coped successfully with the leaf from a feddan of tobacco. However as the leaf is picked over a period of some weeks it would normally be advisable to have a number of barns for easily controlled curing. The tobacco was fire cured, curing normally taking about three weeks.

5. *Conditioning.*

After curing, the leaf was allowed to absorb moisture from air overnight, and then stacked in heaps in the store according to Uganda practice. Heaps are maintained under pressure and periodically examined to make sure that no heating or mould formation has occurred.

6. *Quality.*

Following fire curing, leaf was graded on the basis of colour, spotting, insect damage and general quality.

Yields in rotls per feddan on this basis were as follows :—

			G I	G II	G III	Total
Virginian	..	..	21	180	513	714
Western	..	..	26	135	472	633
Burley	..	..	30	173	270	473

The low percentage of Grade 1 leaf is a result of *Cercospora* and cutworm damage. Disease also accounted for a high percentage of ungradeable leaf, not included in the above figures.

From the point of view of both yield and quality Virginian Hybrid proved the best variety ; Burley was fair and Western far too strong for normal palates.

Crudely prepared cheroots made from not fully conditioned Virginian leaf were quite smokable and probably well rolled cheroots from good conditioned leaf will compare favourably with the Congo product. The leaf appeared to be unsuitable for cigarette manufacture, although a milder product might be achieved with carefully controlled curing and conditioning under expert supervision.

Results obtained in the main confirm the experiments of Inspector of Agriculture last season. There seems no reason why a small peasant tobacco industry cannot be built up. Production and curing problems can ultimately be worked out on the spot, but much time would be saved if expert advice could be obtained.

OBSERVATION AND PROPAGATION PLOTS.

Propagation plots were laid down for the maintenance of nearly 300 crop varieties from the former Kagelu Station, the Plant Propagation Section and Kurukwata.

The collection included :—

1. *Grain Crops.*

Varieties of eleusine, dura, maize and rice. A representative collection of eleusine varieties from East Africa was obtained and planted in observation plots.

2. *Beans, Grams and Pulses.*

Varieties of cowpea, gram, pigeon pea, Lima bean and *Phaseolus vulgaris*.

3. *Other Food Crops.*

Varieties of groundnuts, earthnuts, soya bean, yams, Coco yams and bananas. A number of varieties of Irish potatoes received from the U.S.A. and Scotland were bulked up and sent to Wad Medani for further propagation during the Gezira winter season.

4. *Oil Crops.*

Varieties of sunflower, sesame and castor.

5. *Fibre Crops.*

A collection of jutes, Deccan hemp, Roselle hemp, sunn hemp, isal, Mauritius hemp and bowstring hemp.

6. *Forage Crops.*

A number of leguminous forage crops were tried, of which *Stylosanthes gracilis* (Brazilian lucerne or stylo) was the most promising.

7. *Nurseries.*

Routine work continued in the citrus nursery and by May 1949 the following budded trees, were available for distribution in Zande District :—

286 Orange, 157 Grapefruit 320 Tangerine.

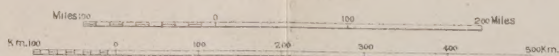
A new nursery has been laid out in the centre of the farm at the junction of the two khors of the River Yabongo and stock planted for next seasons budding programme. Coffee and Tung nurseries were also established using selected seed from Kurukwata.

THE ANGLO-EGYPTIAN SUDAN



Sudan Survey Dept. Khartoum, July 1949 (Topo. No. S. 820 - 48)

Scale 1:8,000,000



REFERENCE

- Boundaries, International
- Provincial
- Railways
- Telegraph Lines
- Roads, All Season
- Dry Season
- Aerodromes (regularly visited)

